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A SERIES OF LECTURES ON SURGICAL NURSING & HOSPITAL TECHNIC

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THE COLUMBUS ACADEMY OF MEDICINE
THE OHIO STATE MEDICAL SOCIETY
THE AMERICAN MEDICAL ASSOCIATION
VISITING SURGEON TO GRANT HOSPITAL

DELIVERED TO NURSES AT GRANT HOSPITAL,
PROTESTANT HOSPITAL, COLUMBUS
STATE HOSPITAL

WITH FIFTY-FIVE HALFTONE ENGRAVINGS
THROUGHOUT THE TEXT, AND SIX PLATES
ILLUSTRATING THE IDEAL OPERATING
ROOM AND ITS ACCESSORY ROOMS

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THE STONEMAN PRESS
COLUMBUS, OHIO

$5.00

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THIS VOLUME IS DEDICATED TO THE MEMORY OF MY PARENTS AS A SLIGHT TOKEN OF LOVE AND GRATITUDE

PREFACE

WHEN I was asked by the Superintendent of the Protestant Hospital Training School to deliver a series of lectures to the nurses on "Surgical Nursing," I did not appreciate the lack of literature on the subject; in fact, but for the many requests I had for copies of my lectures from different points of the state, I never would have realized how inadequately the subject had been treated in the numerous books on nursing, It seems incredible, that progressive as the medical profession is, especially in the line of literature, the nurse's library should consist chiefly of such books as remind us of the commercial productions known as the "Family Doctor" and the "Medical Adviser." Every subject pertaining to nursing is crowded into one small volume; obstetrics is given a few pages, dietetics is briefly discussed, the care of the infant is touched on, a few pages are devoted to materia medica, and so on through the category of the different departments of medicine, while surgical nursing is treated as though it were a minor subject. Feeling that the nurse should be treated with more consideration, I decided to place my lectures in book form in an endeavor to broaden the nurse's education by giving in a simple way the scientific basis of surgical nursing. Indeed, I was further induced to do so from the encouragement which I received from out-of-town practitioners, who expressed a desire for such a work as a guide in the after-treatment of surgical cases that were compelled by circumstances to undergo operations at their homes.

I desire to express my indebtedness to the many authors whose names appear in the various bibliographies of this volume. Their wide experience as surgeons has been of great assistance to me in its preparation.

To those of the profession whose names appear in the text I am under personal obligations because of their interest in the work. In some instances they have donated their valuable time in writing their suggestions on the various subjects on which they are authorities.

To my colleagues Drs. J. J. Coons, J. D. Dunham, W. E. Lloyd, E. N. Ludwig, and W. I. Jones, I especially desire to express my gratitude for the assistance I received at their hands.

Many practical suggestions were made by Mrs. Harriet Fenzel, Superintendent of Nurses at the Protestant Hospital, and Miss Margaret Knierim,

Chief Operating-room Nurse at the same institution, for which I am pleased to make acknowledgment.

The reading of the manuscript and revision of proofs were intrusted to my friend Mr. Paul C. Carty, Instructor of Printing in the Columbus Trade School. The difficulties of such an undertaking are only appreciated by those who have attempted a like task. I am deeply grateful to him for his services.

There is no portion of this book in which my secretary Miss Lucy E. Dodds did not play an important part in its preparation. Many of the lectures were revised by her and reduced to their simplest terms, so as to omit the more technical expressions the profession is prone to use, and to bring the subject-matter easily within the range of the intelligent nurse. All references to authorities were left to her care. She also supervised the sequence of the lectures, besides aiding in the manuscript and in the details incident to the production of the illustrations. Without her aid the book would not have been produced, so that it is a pleasure to express my gratitude, and give credit for the part she had in the work.

With all the help and encouragement I received, and the efforts that were put forth, I feel very much like the one who wrote: "The very best of us leaves his tale half untold, his message imperfect; but if we have been faithful, then because of us, some one who follows us, with a happier heart and in happier times, shall utter our message better and tell our tale more perfectly."

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FOREWORD

THE rapid progress made by surgery in the last few years makes it imperative for the advanced surgeon to call to his aid only such nurses as are qualified to meet modern demands. Of late there has been a great deal of discussion in regard to overtrained nurses, whatever that may mean, but I believe the surgeon who is keeping in the front ranks of his profession is not alarmed at the well-informed nurse, because the nurse whose training has been properly supervised knows her province and sphere. She has been disciplined to realize that it is not her place to make suggestions, but to obey orders, and to carry out her duties in the most approved manner. In fact the higher the degree of education the nurse receives, the more does she appreciate her position, and vice versa, the lower the grade of her educational attainments, the more importance does she assume. There should be no fear in overeducating any one, and especially is this true in work pertaining to the protection of life. I believe the time has passed when the trained nurse should be considered a machine to automatically carry out details. Looking at the subject from a higher-educational standpoint, I am thoroughly convinced that the well-informed nurse is one of the greatest assets a surgeon can possess.

I have taken the liberty of leaving the path so long trod in text-books pertaining to nursing and have endeavored to give the elementary principles of surgery so that the nurse can in an intelligent manner carry out the orders of her surgeon, and be more competent to protect her patient from the many disastrous results which follow in the wake of automatic nursing. For similar reasons I have also mentioned some of the numerous complications following operative procedures and emergency cases, together with the usual treatment for such conditions.

Throughout the volume I have suggested the proper methods of hospital technic, so as to give an adequate idea of the manner in which the surgical department of the hospital should be conducted,—which in many instances is sadly neglected. I fully realize that deviations may be necessary, nevertheless, the principles involved in my suggestions will form a practical basis which may be changed to suit the requirements of any particular institution. In contrast to the facilities offered by a hospital and the technic which is there utilized, I have added a chapter on "Major Surgery in Private Prac-

tice," which I hope will be of interest to the nurse, besides giving her some conception of what her duties will be at the home of the patient.

Criticisms may be offered that the lecture on "General Anesthesia and Anesthetics" is treated too technically, yet this is a subject which cannot be discussed intelligently without entering somewhat into technicalities. However, it is given with the hope that it will aid those nurses who desire to become expert anesthetists, and better enable them to take up the more extensive works on this subject.

C. A. Howell.

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LECTURE I

SOME BRIEF HISTORICAL SKETCHES

Florence Nightingale (1820-1910)

Fragile, remote, a lady dwelt apart
A lifetime's space from all the life of men;
Then softly slept. And England's mother-heart
Grew very tender as she saw again
Sick lads at Scutari, who kissed the pale,
Swift shadow of Saint Florence Nightingale.
—*John Pearson.*

A series of lectures to nurses would be incomplete if at the onset I did not mention the name of *Florence Nightingale, the first trained nurse in the world, and the first to grasp the true meaning of the necessities for the trained nurse.* If any of you have not read the story of this heroine's life I would admonish you to do so. The inspiration one gets from her noble character must leave its impression for good, especially on you who are endeavoring to follow in the line and vocation she instituted.

Born of wealthy parents in Florence, Italy, in 1820, she was baptized for the city of her birth. Her father, William S. Nightingale, was the owner of two large English estates, one of which was Lea Hurst Derbyshire, where Miss Nightingale's childhood was spent.

"There she early developed that intense love for every living, suffering thing, that grew with her growth, until it became the master passion of her life. She was intensely fond of animals, and even after her name had become illustrious, she wrote: 'A small pet animal is often an excellent companion for the sick, for long chronic cases especially.'"

With wealth and education around her, Miss Nightingale soon absorbed that grace and refinement which seemed to play such an important part in her future career. History tells us how these characteristics continually bubbled through her nature at all times. It depicts her sympathy, her intense desire to aid the suffering, and her quiet, lovable, and affectionate nature. The study of nursing was her prevailing ambition.

At the time I am relating, nursing was at such a low ebb, and was considered such menial work, that when servants lost their positions and were

unable to obtain others, they applied for places as nurses in hospitals. Think of the immense chasm Miss Nightingale had to bridge to change public sentiment in England and cause it to look on the trained nurse as next in authority to the physician at the sick bed! Her task has been well done. She molded public feeling to such an extent that today the trained nurse is considered not only as a necessity, but as one who has given up her life exclusively to appease, quiet, and soothe the sick. She transformed the dirty, filthy, slovenly nurse of old to our present model of cleanliness. She changed the despised epithet of "nurse" of former days to the same name that carries with it now fidelity, love, and sympathy.

Miss Nightingale's first active step toward nursing was at Pastor Fliedner's Deaconess's Home at Kaiserworth, where she remained for some months. She next went to St. Vincent de Paul in Paris. On her return to England she reorganized a sanatorium in Harley Street, and was lost to the world for two or three years in her efforts to save this institution. Her work and long anxiety in this place broke down her health.

In 1854 the Crimean War was at its climax. The English newspapers told true but heartrending descriptions of the suffering and maltreatment that was going on in its military hospitals, while hundreds of private letters from the front implored aid.

W. H. Russel, "The Times" correspondent, in one of his letters, wrote: "The commonest accessories of the hospital are wanting, there is not the least attention paid to decency or cleanliness, the stench is appalling, the fetid air can hardly struggle out to taint the atmosphere save through the chinks in the walls and roofs, and for all I can observe these men die without the least effort being made to save them. Here they are just as they were laid gently down on the ground by the poor fellows, their comrades, who brought them from the camps with the greatest tenderness, but who were not allowed to remain with them. The sick appear to be attended by the sick, and the dying by the dying."

Miss Nightingale was then recuperating her health after the years spent in reorganizing the Harley Street Sanatorium. The flower of England had lost its head as to what was best to be done, but Miss Nightingale at once conceived the idea of writing Lord Sydney Herbert, Minister of War, and offering her services. Strange as it may seem Lord Herbert wrote her on the same day, knowing her achievements as an organizer and nurse only too well, and requested her to take charge of the hospitals at the Crimea. In his letter he gave her absolute authority over all nurses, unlimited power to draw on the government for all supplies for the success of the operations, and assured her of the coöperation of the surgical staff, concluding the

letter thus: "Your personal qualities, your knowledge, and your authority in administrative affairs all fit you for this position."

This was on the fifteenth day of October, 1854; on the twenty-first of the same month Miss Nightingale, accompanied by thirty-four nurses, left for the field of action.

Here was not a case where emotion had tempted this beautiful woman to forsake home comforts for the rough life of the battlefield; there was none of the hysteria, so common at such times, that excited her into this mood, but simply the innate love for suffering humanity, the intense desire to help and alleviate pain, and to do as much good as possible with the education she had obtained in the different hospitals where she had visited.

"From October 30, 1854, the heroine of the Crimean War was Florence Nightingale, and the heroine of that war will she be while the English tongue exists and English history is read."

She transformed the miserable hospitals as described by Mr. Russel into places that were veritable solaces for the sick; filth, unwholesome food, and negligence were supplanted by cleanliness, attention, and care. An invalids' kitchen was instituted, laundries established, and personal attention given to nursing.

Such an impression did her character make that "The Times" correspondent wrote: "Wherever there is disease in its most dangerous form, and the hand of the spoiler distressingly nigh, there is that incomparable woman sure to be seen; her benignant presence is an influence of good comfort even amid the struggles of expiring nature. She is a ministering angel, without any exaggeration, in these hospitals, and as her slender form glides quietly along each corridor, every poor fellow's face softens with gratitude at the sight of her. When all the medical officers have retired for the night, and silence and darkness have settled down upon these miles of prostrate sick, she may be observed, alone, with a little lamp in her hand, making her solitary rounds. With the heart of a true woman and the manner of a lady, accomplished and refined beyond most of her sex, she combines a surprising calmness of judgment and promptitude and decision of character. The popular instinct was not mistaken, which, when she set out from England on her mission of mercy, hailed her as a heroine; I trust that she may not earn her title to a higher, though sadder, appellation. No one who has observed her fragile figure and delicate health can avoid misgivings lest these should fail." Even Longfellow wrote the charming poem, "The Lady with the Lamp," while the statue of Florence Nightingale at St. Thomas's Hospital, England, testifies to the love the people had for this wonderful woman.

A letter from a soldier tells of the love the men at the front had for her. It reads like this: "She would speak to one and another, and nod and smile

to many more; but she could not do it to all, you know, for we lay there by the hundreds; but we could kiss her shadow as it fell, and lay our heads on our pillows again, content."

Can you conceive of anything more beautifully impressive than that? Can you gather any moral that we should try to cultivate after hearing these lines? Can you fully appreciate the longings of a patient for her nurse? The long hours of sickness and pain create in us a desire for love and affection, and who can give it better than the nurse? There are so few of us who are true to our profession.

In acknowledgment of Miss Nightingale's splendid work Her Majesty presented her with a "beautiful and costly decoration," and the nation gave her two hundred and forty thousand dollars as a recompense for what she had done. This, however, she refused to accept for herself, but used it to build the Nightingale Home—a home for nurses.

This wonderful woman died August 13, 1910. Probably no crowned head could have had a more imposing furneral than our heroine, had she so desired, but true to her nature she especially requested the simplest form of services to be held. The universal expressions of sorrow and regret from every class and from every nation mark her as one of the most imposing characters of this century.

I could delineate to a greater length on the achievements of this noble woman, but sufficient I hope has been said to instill within each of you a desire to read the several memorials that have been written about her; and I hope sufficient interest has been aroused to show you what a noble vocation nursing has become, how far reaching is its influence, and what obligations you owe the profession you have chosen for your own.

THE INTERNATIONAL RED CROSS SOCIETY

This society was founded in Geneva, Switzerland, in 1863, but the necessity for such an organization really had its inception in the mind of Florence Nightingale during the Crimean War.

It was Henri Dunant, a Swiss, who really laid the foundation for the present concrete society, having witnessed the massacre at Mantua, Italy, in 1859, when there lay sixteen thousand French, and twenty thousand Austrians, dead and wounded on the field of carnage. Recognizing how inadequate were the hospital facilities, he proposed to a philanthropic society at Geneva to establish a volunteer medical force to supplement the regular army surgeons during war. A general invitation was then sent out and

fourteen countries were represented. Turkey, Greece, and Portugal, and the papal states were marked by their absence. America was not represented.

"The delegates recommended that each government extend its sanction, authority, and protection to sanitary commissions and their relief corps, that in time of war the privilege of neutrality be extended to ambulances, military hospitals, officials and attaches of the medical service of the army, and to the inhabitants living in the theatre of war who should receive and care for the wounded in their houses, and that the universal insignia and flag should consist of a white flag or band with a red cross. This was adopted as a tribute of courtesy to Switzerland, the parent country of the idea, whose flag is a white cross on a red background. The United States was represented the following year; its two delegates reported at the second meeting of the Red Cross, the success this country had with its sanitary commission at the opening of the Civil War. This testimony from the United States, setting forth the practicability of a movement similar to the Red Cross, was a splendid inspiration to the founders of the new organization."

A similar society was founded in this country the year following the close of the Civil War known as the "American Association for the Relief of Miseries on the Battlefield." Associated in this movement, the name of Clara Barton (1821-1912) should be brought to your attention. She was a clerk in Washington when the hostilities between the North and South began, and entered the hospital service of her country. "Subsequently she gave her service in the Franco-Prussian War and at its close was decorated with the Gold Cross of Baden and the Iron Cross of Germany. It was through her efforts that the American Red Cross of today was organized in 1881; she remained its president until 1904. The International Red Cross acts under the only universal conservation treaty in existence." All nations belong to it according to an agreement of 1906, its operations extending even to naval warfare. The Asiatics were the last to sign the agreement. Its labors are not limited now to warfare, but to all catastrophies, such as earthquakes, mine disasters, fires, tidal waves, and epidemics.

It is this society which is making such a fight against tuberculosis and which issues annually at Christmas time the Red Cross seals or stamps, the sale of which amounted to over three hundred and fifty thousand dollars the first two years.

THE PRE-ANTISEPTIC AGE

Wherever men are gathered or encamped in large numbers there epidemics occur, unless modern medicine steps in and by its marvelous sanitary methods prevents devastation of human life,—the Crimean War was a fearful example. Soldiers were killed in battle by tens of thousands, but

they were dying with various diseases by hundreds of thousands. This war was the last in which the old methods of treating wounds were used; it was the so-called pre-antiseptic age. Hospital gangrene from the most trivial injuries was more common than gunshot wounds, erysipelas could be seen devastating whole camps, and a pall seemed to rest on the greatest minds in surgery,—so beaten back and overcome by the lack of science that the stoutest-hearted and boldest surgeons were discomfited and discouraged, and their former vigorous enthusiasm was on the wane.

LOUIS PASTEUR (1822-1895)—SIR JOSEPH LISTER (1827-1912)

On the horizon there appeared Louis Pasteur, a French chemist, who in 1858 announced that *fermentation and putrefaction were due to microörganisms or bacteria, which are minute vegetable organisms.* This keynote was grasped by another, and the world was to see the turning point from slovenly and filthy surgery to one which has as its basis "surgical cleanliness." Picking up the lines or keynote left by Pasteur, Sir Joseph Lister in 1865, working with undaunted courage and overcoming all difficulties, even at the criticism and ridicule of his brother surgeons, issued his "Germ Theory of Disease."

The opposition that this theory met with and the epithets that were hurled at this author would have deterred anyone, save and except one like Sir Joseph Lister. Such eminent men as Lawson Taite, than whom there was never a greater surgeon, ridiculed his methods even to the time of his death, and men of like standing never lost a chance to jeer his theories. This year marked the birth of modern clinical surgery.

Lister believed that *microörganisms or bacteria entering into wounds caused inflammation and its sequela suppuration or pus, and that the atmospheric air was the vehicle or carrier by which germ life was transplanted into wounds.* He began experimenting, having chiefly in mind two points, (1) the disinfection of the air around the field of operation, and (2) the keeping of the wound in such a state as to prevent the entrance of bacteria into the tissues.

After experimenting with various drugs he decided that *carbolic acid* was the remedy *par excellence.* He therefore designed large steam atomizers that sprayed this irritating substance, not only through the operating-room to keep the air purified, but also a continuous spray was maintained over the hands of the operator, the instruments, and the field of operation, and it is even within the memory of the writer when such a technic was carried out. I well remember one of the first Cesarean sections that ever occurred in Ohio to my knowledge, when one was unable to see the surgeon across the room on account of the spray from one of these steam atomizers. No ridi-

cule must be made of this crude technic; it became the corner-stone for our modern surgery, and gave excellent results as compared to the methods employed by the older surgeons. Compound fractures which had a mortality of nearly eighty per cent. soon lost their fatality, hospital gangrene soon became amenable to treatment, and hospitals which formerly had been pest-houses and had to be closed for months at a time on account of the ravages of erysipelas and other contagious diseases, now became homes of refuge.

Sir Joseph Lister fortunately was the son of a wealthy English wine merchant; the elder man was somewhat of a scientist, and this trait was greatly amplified in the younger Lister, who not only accomplished what I have already related, but went further and helped to develop the microscope; in this way he carried on his research work and placed it on a basis above ridicule. He truly burned the barriers away, and blazed the path for future generations.

Finally to him must be attributed the honor of having first used absorbable animal tissue for ligatures and sutures. It would be impossible to estimate the value of this discovery to surgeons, as many of our most brilliant operations could not be accomplished without animal sutures. Lister therefore is one of the greatest of our patron saints. His name and what he has accomplished for mankind can never die, and it is but fitting that before entering on the subject of "Surgical Nursing," the names of Florence Nightingale, Louis Pasteur, and Sir Joseph Lister be brought to your notice, and the origin of the Red Cross, which forms the insignia of your profession, be mentioned.

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LECTURE II

SURGERY, SURGICAL NURSING, INFECTION, NATURAL RESISTANCE, ARTIFICIAL MEANS TO INCREASE NATURAL RESISTANCE

Surgery is that branch of medicine which treats diseases by mechanical methods or operative procedures.

Surgical Nursing is that art which the nurse uses in the care of surgical cases.

Principles of Infection.—As the knowledge of this subject is one of the foundation principles on which modern surgery is based, I have chosen this as the first topic for discussion. In fact, so important is the knowledge of this subject, that it forms the keynote of the entire field of modern medicine.

The historical facts I have related, as first suggested by Sir Joseph Lister, are as true today as when he first discovered them. His idea that the entrance of germs into the tissues causes inflammation, is our present knowledge of what is known as infection.

"When bacteria, sufficient in number or virulence to overcome the natural resisting powers of the tissues, have gained entrance in the economy, it is infected."—Jas. E. Moore, M. D. In other words, *infection is the successful entrance and multiplication of bacteria in the economy.* When the infection is limited to a small area it is known as a *local infection,* the symptoms of which are recognized as inflammation, heat, redness, swelling, pain, and suppuration or pus,—the last step in this process,—*which is simply "the molecular death of the tissues in a state of solution."* When the infection has spread so that the blood-current has become contaminated it is termed *general infection.* (See lecture on "Some Postoperative Complications," sections "Septic Intoxication," "Septicemia," and "Pyemia.")

After bacteria have gained a foothold in the economy they eliminate toxins, *which are chemicals or poisons capable of producing a similar infection to the bacteria from which the toxins are obtained.* So that by the term *toxemia* is understood *blood-poisoning. Ptomains* are the poisonous products eliminated from *putrefactive bacteria only.*

Some of the More Common Bacteria.—There are numerous kinds of bacteria capable of producing infection, but it is not necessary to mention all

the different varieties. Those which are met with most frequently are, (1) the streptococcus, (2) staphylococcus, (3) gonococcus, (4) the colon bacillus, (5) pneumococcus, (6) the tubercle bacillus, (7) tetanus bacillus, and to these may be added (8) the spirocheta pallida. The history, morphology, and other data concerning these you have gained in your study of bacteriology.

A *simple infection* is one caused by a single variety of bacteria. By a *mixed infection* is inferred that two or more varieties of microörganisms are producing the pathologic condition, while a *secondary infection* is where the primary infection has been aggravated by the entrance of entirely different bacteria.

Secondary infections are not always the result of carelessness, yet I think I am conservative in saying in a large majority of cases they are. Frequently one witnesses operations performed in the most aseptic manner, careful consideration given each detail, and then sees an equal amount of carelessness exhibited in the dressing the part receives from time to time. Hence I say *careless methods are very often the gateways* through which secondary infections occur.

Avenues by which Bacteria Invade the Economy.—There are numerous portals through which bacteria may gain entrance, among which may be mentioned *wounds* or *abrasions.* Any break in the continuity of the body-surface invites the invasion of microörganisms. A wound may become infected from the following sources: (1) Dirt or infectious material on the instruments or any other means by which the wound was inflicted, (2) similar material on the wounded part, (3) infection on the hands of the attendants, (4) instruments or suture material not thoroughly sterilized, (5) septic dressings.

Infection may take place without the presence of a wound or abrasion. Under the outer layer of the skin lives the staphylococcus epidermis albus, in which locality this microörganism seems to remain latent, or domesticated. When a part of the body-surface has received a *trauma or blow* insufficient to produce an abrasion or wound, but yet of such severity as to *reduce the resisting power of the part,* these microörganisms gain a foothold and an infection ensues. Again the resisting power of a part may be reduced by *anything that interferes with its circulation,* as an example, excessive tension of sutures that coaptate the edges of a wound. Bacteria may gain entrance through the skin by *penetrating the shaft of a hair-follicle,* in this way producing a severe inflammatory action, such as is seen in carbuncles, boils, etc. A few of the most virulent forms of microörganisms are capable of *passing directly through the mucous membrane* whose surface continuity has not been broken. Because of the high resisting power of this tissue,

and the fact that the bacteria have to be of the most infectious type, this form of invasion is not a frequent occurrence. Another common way for infection to occur is through the *uterine canal* (especially in connection with abortions) or by the use of dirty instruments introduced within its cavity. Infection following surgical operations may develop from any, or all of the sources I have mentioned. The *respiratory tract* and the *gastro-intestinal canal* are other channels by which bacteria enter the economy.

The question may arise as to *the manner in which infection spreads* through the system after bacteria have gained entrance. If the natural resisting powers of the economy are not great enough to overcome the invading bacteria, the absorbents, known as the lymphatics, absorb these microörganisms or their toxins, or both, and eventually empty this septic material into the blood. Occasionally, however, an infection is so rapid in its progress and so devastating from the very onset, that one is forced to conclude that microörganisms enter the capillaries *directly,* and thus gain entrance into the blood-current; in other words, short-circuit the route, but this latter is not the general mode of invasion.

The Lymphatic System.—The lymphatics or absorbents of our bodies are composed of (1) spaces without any definite limiting wall, situated chiefly among the capillary blood-vessels; from this origin begin (2) lymph-vessels of various sizes which communicate freely with each other and possess numerous valves to prevent "back flow" of their contents. During the course of these vessels glands are seen; the vessel entering such a gland breaks up into numerous smaller vessels, and again unites to form a trunk when leaving the gland. (3) Glands. These, as I have mentioned, are found in the course of the larger vessels; their function being to purify the contents of the vessel. In other words they are purification plants, or filtration depots. These numerous vessels converge into two trunks, the thoracic and right lymphatic ducts, which pour their contents into the left and right subclavian veins respectively. Thus *a direct communication is established between the lymphatic and vascular systems.* The contents of these vessels, whether it be normal lymph or infectious material, is *propelled through the lymphatic system by muscular movement.* This composite stream is known as the *lymphatic-current.*

I desire to indelibly impress on your minds the fact, that *if a local-infected area is so immobilized that muscular movement of the part supplied to the surrounding lymph-vessels is prohibited, the lymph-current is checked, and a general infection averted in a large majority of cases.* This is the foundation principle in the treatment of all infections.

The Exit by which Bacteria Leave the Economy.—It has not been clearly demonstrated how bacteria are *excreted from the body,* but clinical expe-

rience indicates that the *kidneys are the chief organs concerned in their elimination.* Such an important factor should ever be borne in mind in the *preparation and after-treatment of all surgical cases.*

Natural Resistance.—The next subject I desire to call your attention to is the steps Nature takes to protect herself. Studies along the lines of "natural resistance," "protective agencies," or "body-resistance," which the economy exerts in self-defense, have only thrown a meager light on this important subject. I say the knowledge is limited, but the little that is known I desire to explain.

In your study of physiology you have learned the constituents of the blood and the respective functions of each. You will recall how the white blood-corpuscles or leukocytes act the dual role of soldiers and scavengers; how they devour and digest bacteria and necrotic tissue produced by an inflammatory action; how they make away with putrefactive conditions, when present, and blood-clots which are left from surgical operations or hemorrhages. This function is termed *phagocytosis.*

Another important function attributed to the leukocytes is *their power of eliminating chemical products, or alexins,* as they are termed, which assist in the destruction of pathogenic microörganisms. These important leukocytes, however, are impotent to cope with bacteria and their toxins by themselves; they need ammunition just as soldiers in the field do for an attack on an invading army. This is supplied in the blood-serum, which possesses (among other protective agencies) opsonins, which acting chemically on the invading microörganisms prepare them for destruction by the phagocytes (a variety of leukocytes). A deficiency of this serum, or the lack of some of its constituents, will prevent these little discs from functionating to their normal capacity; therefore, these two elements of the blood (leukocytes and blood-serum) depend the one on the other for their ultimate success as protective agents.

In making a comparison between the function of the blood-corpuscles and soldiers, I have in no way exaggerated the picture. Within a normal body there are from eight to ten thousand white blood-cells in every c.mm. of blood which constitute its standing army. In most infectious diseases this number is increased, so that reinforcements are called forth to an extent where every c.mm. may contain one hundred thousand of these cells. If the invading army is powerful, that is to say, if the infection is virulent, Nature calls on her resources proportionately for protection.

Blood-counting.—The estimation of the number of red and white blood-corpuscles is termed *blood-counting. An increase* of the normal number of white blood-cells is termed *leukocytosis, a decrease of the same, leukopenia.* When a blood-count is made and the number of white blood-

corpuscles stated, this is called the *absolute count,* and indicates the *amount of self-defense or resisting power the patient possesses. By the term differential, or relative count, is understood the number of each variety of leukocytes found in the absolute count.* For all practical purposes it is only necessary to call your attention to that variety termed "polynuclear neutrophiles," or in hospital parlance "polynuclears," which are found in the ratio of 75 per cent. of the leukocytes in normal blood of the adult. *The higher the per cent. of polynuclears, the more severe is the infection. To be concise, the higher the absolute count, the greater is the patient's resisting power; the higher the per cent. of polynuclears, the graver is the infection. A blood-count to be valuable should be made repeatedly. An increasing absolute count indicates an increasing infection, and a proportionate body-resistance. A decreasing absolute count, with the ratio of polynuclears not decreasing, indicates the patient's resisting power is waning.* Thus knowing the amount of resisting power as shown by the absolute count, and the virulence of the infection as indicated by the differential count, the surgeon is in a position to give a definite prognosis, or decide whether an operation is advisable in the presence of an acute infection.

TABLE INDICATING AN APPROXIMATE RATIO BETWEEN THE ABSOLUTE AND DIFFERENTIAL COUNTS.

Compiled by J. J. Coons, M. D., Columbus, Ohio.

Absolute count or Amount of resistance.	Differential count or Amount of virulence.
74000	96.6
73000	96.56
72000	96.52
71000	96.46
70000	96.43
69000	96.37
68000	96.33
67000	96.27
66000	96.21
65000	96.15
64000	96.1
63000	96.
62000	95.96
61000	95.9
60000	95.83
59000	95.75
58000	95.7
57000	95.6

Absolute count or Amount of resistance.	Differential count or Amount of virulence.
56000	95.5
55000	95.4
54000	95.35
53000	95.28
52000	95.2
51000	95.1
50000	95.
49000	94.9
48000	94.8
47000	94.7
46000	94.5
45000	94.4
44000	94.3
43000	94.15
42000	94.
41000	93.9
40000	93.8
39000	93.6
38000	93.4
37000	93.2
36000	93.
35000	92.8
34000	92.6
33000	92.4
32000	92.1
31000	91.9
30000	91.6
29000	91.3
28000	91.
27000	90.7
26000	90.3
25000	90.
24000	89.5
23000	89.1
22000	88.6
21000	88.
20000	87.5
19000	87.
18000	86.1
17000	85.2
16000	84.3
15000	83.3
14000	82.1
13000	80.
12000	79.1
11000	77.2
10000	75.

There are certain localities in the economy where the *resisting power* of the body seems to be *greater than others,* and fortunately it is so; because these are localities where artificial means of sterilization cannot be used, such as the rectum, vagina, mouth, nose, etc.—as a general proposition, the mucous membranes lining the orifices of the body. These openings are subject all the time to infection from numerous bacteria, but become more or less immune.

There are some tissues that seem very *susceptible* to infection, viz., the medullary substance of the long bones, fat, and synovial membrane. This should be borne in mind, and the most rigid precaution taken when operations are made involving these tissues.

Formation of an Inflammatory Action.—After bacteria have entered a part of the body and eliminated their toxins, an inflammatory action is aroused. The bacteria and toxins cause a paralysis of the vasoconstrictors of the local blood-vessels, their walls relax, and for a short time the *blood flows freer than normal* (*active hyperemia.*) Soon, however, there is a *slowing down of the current* at the point of infection (*passive hyperemia*). When this last step takes place, the leukocytes pass from the blood-stream, accumulate around the walls of the vessels, and the migration of these body soldiers to the field of action is about to take place. Changing their shape they penetrate the endothelium of the capillaries, and soon emerge into parts where the bacteria have pitched their camp. In the meanwhile the transudation of serum around the area containing the invading bacteria and leukocytes is begun, and the battle for supremacy is on.

The presence of bacteria with their toxins, the increased pressure from the serum which has been poured out from the engorged blood-vessels, the malnutrition under which the part is laboring because of the retarded circulation, and the numerous leukocytes which have migrated from the blood-vessels, all have a tendency to produce necrosis (breaking down) and liquefaction of the tissues. The leukocytes are performing their function, some repelling and some enveloping the intruding bacteria, while others are devouring and making away with this necrotic tissue. This function of the white blood-corpuscles is termed *phagocytosis.* If the virulence of the infection is severe, and the necrotic process with its liquefaction great, it is termed *suppuration or pus;* hence, the philosophy of the definition, *"pus is the molecular death of a part in a state of solution."* From the very nature of things it must contain bacteria and their toxins, exudates, leukocytes of all kinds, necrosed or broken down tissues, besides other constituents of the blood. After the pus has been evacuated from an infected area, a cavity must result, which needs repair. (See lecture on "Wounds.")

Artificial Means of Assisting Natural Resistance.—There are two means by which this may be accomplished at the present time—artificial hyperemia and vaccines.

Artificial Hyperemia.—I have purposely given you some idea of the conditions which occur during the process of an inflammatory action so that you may appreciate to some extent, at least, the theory of *artificial hyperemia* as first suggested by Prof. Bier of Berlin. There are two principles to be borne in mind, (1) *an inflammatory action is simply a process on the part of Nature for self-defense, and* (2) *artificial hyperemia has for its object an increased amount of blood to a diseased area.* By artificially increasing the quantity of blood to any diseased part the *resistance of that part is raised,* because (1) there is an increase of leukocytes and their alexins (in other words a local leukocytosis is produced), and (2) there is an increase of serum with its opsonins and other protective agents. There are two classes of artificial hyperemia, (1) *venous or passive, and* (2) *arterial or active.*

Means for the Production of Hyperemia.—

(1) The employment of an elastic bandage.

(2) The application of vacuum-cups or cupping-glasses.

(3) By utilizing superheated air.

The elastic bandage or vacuum-cup produces a venous or obstructive hyperemia by retarding the blood-stream on its return to the heart. The superheated air causes an arterial hyperemia by producing dilatation of the blood-vessels.

The Elastic Bandage—Rules for Applying the Same.—(1) The width of the bandage should vary according to the part to be constricted, and be of sufficient length to encircle the desired area two or more times.

(2) The bandage is applied proximal to the infected area, that is to say, if the focus of infection is in the hand, the bandage is adjusted above the elbow; if in the foot, it is applied somewhere above the knee; if in the face, the neck is the point of constriction.

(3) The bandage should be applied *snug enough to slightly constrict the caliber of the veins, but not sufficient to obstruct the bore of the arteries, the pulsation of these latter vessels must always be distinctly felt below the bandage.* In this way the arterial blood passes freely to the part, but the venous return is retarded, consequently the veins below the point of constriction should stand out prominently, and the skin assume a *bluish-red or dusky tinge.* The application of the bandage *should never produce pain,* in fact, a properly applied bandage relieves this symptom at the point of

infection, moreover the temperature of the part should be *slightly increased, never diminished.*

(4) All dressings on the infected area which compress the part should be removed during the process of the treatment, because swelling ensues when artificial hyperemia is used.

(5) During the intervals that the hyperemic treatment is suspended, the member should be elevated so as to favor the absorption of the swelling.

(6) The part which has been compressed by the obstructive bandage should be gently massaged, or rubbed with alcohol.

(7) The duration of each application will vary from four to twenty-two hours per day.

Thus you can see, this form of treatment imitates the symptoms of an inflammatory process; that is, there is an increase of heat, redness, and swelling, but with the absence of pain, and, as I have told you that inflammation is simply Nature's effort at self-defense, you will appreciate how this treatment is a reinforcement of her methods.

Suction Apparatus or Cupping-glasses.—These are of various sizes and shapes, so as to fit the different contours of the body. They vary from the simple bell-shaped cup equipped with an ordinary rubber bulb (which when squeezed produces a vacuum within the cup after the latter is applied to the affected area), to some of the most elaborate suction apparatus, capable of holding a hand or foot, and equipped with metal pump and three-way stopcock. At the present time they can be obtained at any of the leading instrument houses.

By applying a suction-cup or any of its modifications, and producing a *proper amount* of vacuum in the same, the skin and underlying tissues are drawn into the cup and assume a bluish-red color, due to the superabundance of blood sucked into the vessels supplying the tissues. A venous hyperemia is thus produced without pain; but, if the suction is *too intense,* the pressure on the tissues will be so great that the blood-supply will be cut off and the part appear anemic and exceedingly painful, which is certainly not the desired end.

This method of producing artificial hyperemia has a very extensive application, because it not only affords increased local resistance to an infected area, but, by its mechanical suction, it is capable of aspirating the contents of an abscess cavity through a *very small* opening which would otherwise have to be evacuated through a *much larger exit.* It therefore is an adjunct to *cosmetic surgery.*

The rules for the application of these various forms of suction apparatus are similar to those already given for the application of the elastic bandage. To which may be added—

(1) In using a suction-cup, anoint the skin over which the same is to be applied with vaselin to insure an air-tight application.

(2) The duration of each application should be five minutes, six times per day.

(3) After the use of a suction apparatus in suppurative cases, the glass portion should be sterilized by boiling and the rubber attachments thoroughly cleansed before being used again.

Superheated Air Apparatus.—The hyperemia produced by this means is of the arterial variety, and is more indicated in chronic inflammatory affections than in acute inflammations. Its chief sphere is in the absorption of exudates, infiltrations, etc. The use of hot poultices, counter-irritants, stimulating liniments, etc., are only other means of producing arterial hyperemia, and their beneficial effects are due solely to their influence on the local circulation.

Vaccines.—The use of vaccines to artificially increase the natural resistance of the economy was first suggested by Sir A. E. Wright of England. *A vaccine,* as at present understood, *is a mixture of bacteria killed by the aid of heat and sterilized in some antiseptic solution; each cubic centimeter of which represents a definite number of germs. The microörganisms entering into the mixture being either obtained from the focal point of infection (autogenous vaccines), or from germs identical with those producing the inflammatory condition;* the former being preferable.

Wright's Hypothesis.—(a) An opsonin is one of the normal protective agents contained in the blood-serum, its action being to prepare bacteria for destruction when coming in contact with the leukocytes.

(b) There is supposed to be a specific opsonin for each pathogenic bacterium; that is to say, one for the staphylococcus, another for the gonococcus, etc. This, however, is denied by some authorities who claim a multiple action for the opsonins; in other words, a single opsonin being capable of acting on several pathogenic bacteria. This latter theory is gaining more general acceptation.

(c) When the opsonins are up to a normal standard in the economy and the blood-serum is in no way interfered with, an infection will not occur, because the natural protective agencies are sufficient to protect the economy.

(d) A deficiency of opsonins, or an inability of the blood-serum to transude around a focus where pathogenic bacteria have entered, permits

the propagation of the invading microörganisms, and infection develops because the leukocytes are unable to cope with the invading host without the assistance of the blood-serum and its opsonin.

The points, therefore, to be emphasized, are, (1) *the function of the blood-serum and the protective agents it contains (in the presence of infection) is to prepare bacteria for destruction by the phagocytes, which when accomplished is termed phagocytosis.* (2) *"The capacity of the serum to produce phagocytosis is spoken of as 'phagocytic index' and a comparison of the phagocytic index with another, or several others, from presumably normal individuals, gives the so-called 'opsonic index.'"*—A. P. Ohlmacher, M. D.

Wright's Dictum.—If in the presence of infection the opsonic index is below normal, the subcutaneous injection of a vaccine administered at proper intervals and in proportionate doses will raise the opsonic index,—in other words, increase the resisting power of the economy.

Dose and Frequency of Administration.—The number of bacteria that is necessary to enter into a vaccine injection will depend entirely on the *amount of resisting power* the patient possesses, and the *virulence of the infection, as indicated by a blood-count.* The frequency of administration depends on the *amount of reaction* that occurs after an injection and the *duration* of such reaction.

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LECTURE III

ANTISEPTICS, DISINFECTANTS, GERMICIDES, DEODORANTS, STERILIZATION

A disinfectant or germicide is a chemical agent which *destroys the vitality* of bacteria.

An antiseptic is a drug which *retards the growth* of bacteria.

A deodorant is a substance which *destroys offensive odors.* Occasionally a drug possesses all three characteristics,—carbolic acid is an example. When used in a strong solution (5 per cent.) it is germicidal; in a 1- or 2-per cent. mixture it is an antiseptic, while its natural odor makes it a good deodorant.

From the time (1865) Lister wrote his "Germ Theory of Disease" the profession has been looking for some drug which is capable of destroying bacteria, and at the same time be harmless to the tissues. The manufacturing pharmacists have not been slow with their commercial ideas, and have placed on the market numerous proprietary nostrums, none of which are valuable as germicides; this fact I desire to impress on you, because in surgical nursing your opinion may be asked by the family along these lines. Never under any circumstances advise a family to invest in these patent drugs.

In giving a list of antiseptics I have endeavored to mention only those that are in common use by the profession.

Bichlorid of Mercury (Corrosive Sublimate) undoubtedly is the favorite American disinfectant. It has its limitations inasmuch as it is highly poisonous, extremely irritating in strong solution, and corrodes instruments. It is put on the market for surgical use in 7½-grain tablets; by the addition of an equal amount of citric acid or chlorid of ammonia the mercuric salt is made more soluble, besides preventing to some extent the formation of an albuminate of mercury when used in the irrigation of wounds. The addition of anilin-blue to these tablets should always be insisted on, because it identifies the solution from others used in the operating-room. As an

irrigation for infected wounds it should never be used in a stronger solution than 1:5000. Some surgeons, however, use it in a stronger solution.

Biniodid of Mercury.—Through the efforts of McClintock this drug has been brought to the notice of the profession as a germicide. The claims put forth are: it is five times more germicidal, does not produce an albuminate when in contact with fresh tissue, is not irritating, and will not corrode instruments; none of these desirable features are found in bichlorid of mercury. When a solution of this latter drug comes in contact with bacteria it immediately coagulates the albumin on the cell-wall which prevents the germicidal action of the solution from penetrating into the protoplasm of the cells; besides, as I have mentioned, it is extremely irritating and capable of producing a thin film of necrosis, even in very attenuated solutions, hence it seems probable that this new preparation (biniodid) is destined to supersede the old drug. The only drawback that has been attributed to it, is its lack of permanency, so that it cannot be kept indefinitely. It is marketed in tablets, or discs, having the following formula:

Mercuric Iodid	gr. 3/8
Potassium Iodid	gr. 3/8
Sodium Bicarbonate	grs. 16

Carbolic Acid, Creolin, and Lysol are mentioned together because they are closely related, being derivatives of coal-tar.

Carbolic Acid can be mixed with water to the extent of a 5-per cent. solution, in which strength it is a disinfectant. It is irritating to fresh tissue, and as an irrigating solution in wounds it should not be used stronger than 2 per cent. Its antidote is alcohol, which must be applied freely.

Creolin and *Lysol* are used chiefly by obstetricians. When mixed with water these drugs make a soapy, oily solution, more suitable for vaginal douches than either carbolic acid or the mercuric preparations, these latter constrict the vaginal canal. *Lysol* is used in from 1- to 3-per cent. solution; for *repeated* vaginal irrigation a 0.50-per cent. solution ($\frac{1}{2}\%$) is the maximum strength that the average patient will tolerate. Creolin is less irritating than either carbolic acid or lysol, and probably possesses less germicidal qualities. It may be used in strengths varying from 2 to 4 per cent.

Iodin.—I desire to call your attention especially to this drug, because it is being used more and more as a germicide. Some of its ardent advocates claim *it does not produce necrosis* in wound cavities as other antiseptics, and *has a more penetrating effect* in freshly cut tissues than any other germi-

cide. If the advice of army surgeons is accepted, all other disinfectants would practically be discarded in favor of this drug. I have used it in suppurating cavities for the last fifteen years, and as a *final step in preparation of the field of operation.* I think it deserves more general use than has been accorded it. It should also hold an important position in country practice, where aseptic conditions cannot be thoroughly obtained, or in emergency surgery in factories, where everything that surrounds the injured is septic. The officinal tincture is the preparation used. A solution of the tincture with benzin or gasolin (from 1 to 3 per cent.) is employed by some surgeons at the present time in the preparation of the field of operation, the philosophy of which will be given in the lecture devoted to the "Preparation of the Patient for Operation."

Formaldehyd is a powerful gas, and in this form is used to disinfect rooms, clothing, etc., after contagious diseases. An aqueous 40-per cent. solution is made and sold under the name of *Formalin.* This solution is used as a disinfectant in strengths varying from 1:2000 to 1:200. Formalin was more popular formerly as a general surgical antiseptic, but its intensely irritating nature and the harshness it imparts to the tissues prevent its general adoption.

Evaporating Lotions may be classed as antiseptics. Their chief ingredients being boracic acid, alcohol, and menthol, diluted with water, render them mildly antiseptic; they also form a pleasant dressing for sprains, contusions, abrasions, and superficial infections after the parts have been put at rest. The following formula is recommended:

℞

Boracic Acid .... ℥ 4
Glycerin .... ℥ 11
Water .... pts. 8
    Mix and boil 15 minutes.
Add Alcohol .... ℥ 11
Menthol .... ℥ 1
    Mix and filter.

Harrington's Solution.—This is being used by some of the leading surgeons of the country as a disinfectant for preparing the field of operation and for hand sterilization, with excellent results. The formula was designed by Harrington of Boston. Its capacity for destroying bacteria is twenty times greater than any known germicide—a most admirable feature. It is no more irritating than any other drug of this class. Unsterilized hands washed in this solution for the period of one minute, become sterile, so that no bacterial growths can be obtained from the scrapings made from such

hands. Clinical experience seems to bear out these statements. The following is the formula:

℞

Bichlorid of Mercury	grs. 48
Hydrochloric Acid	℥ 8
Water (distilled)	pts. 2½
Alcohol	pts. 5½

Mix.

Potassium Permanganate is a purple polyhedral crystal. It is used in solution from 1:100 to 1:10, chiefly as an antiseptic for the hands, which it stains a deep purple. This drug was more popular formerly than at present. The stain it leaves after sterilizing the hands is decolorized by the next drug I will mention.

Oxalic Acid.—This is a very poisonous and irritating drug, although it is claimed to be a highly efficient germicide. When potassium permanganate and oxalic acid were first used in the preparation of the surgeon's surgical toilet, many controversies arose as to which was really the disinfectant; eventually it was decided in favor of the latter.

Chlorid of Lime—Carbonate of Soda.—When these are mixed together in equal proportions and moistened with water to form a paste, chlorin gas is eliminated, which possesses high disinfectant qualities. This combination forms a favorite germicide for hand-sterilization among some surgeons. The readiness with which these drugs can be purchased at any drug store only enhances the value of this method in operations occurring remote from hospital service.

Argyrol is a definite chemical compound of silver, containing 30 per cent. of that metal. The various combinations of silver possess more or less antiseptic qualities and are irritating to the tissues to a greater or less extent. This preparation, however, is very efficient as an antiseptic and practically non-irritating. It does not precipitate albumin or sodium chlorid, another very meritorious quality. It is used chiefly in infections of the mucous membrane, in solutions varying in strength from 2 to 50 per cent. It permanently stains linen. Solutions deteriorate rapidly, and should be freshly prepared when needed.

Hydrogen Dioxid (Aqua Hydroganii Dioxidi) is a useless article when employed as an antiseptic or disinfectant. It has no such properties, and really should not be classified with them. The sphere of its usefulness lays in the fact that it eliminates its oxygen freely when in contact with organic matter. It is therefore useful to remove blood-clots, necrosed

tissue, and other debris in wounds and ulcers. It possesses hemostatic qualities, and may be utilized in minor venous oozing.

APPROXIMATE WAYS OF MAKING ANTISEPTIC SOLUTIONS BY APOTHECARIES' MEASURE.

To make 1 oz. of a 1:500	solution use	1	grain of the drug.
To make 1 pt. of a 1:500	solution use	15	grains of the drug.
To make 1 qt. of a 1:500	solution use	30	grains of the drug.
To make 1 qt. of a 1:1000	solution use	15	grains of the drug.
To make 1 qt. of a 1:2000	solution use	7½	grains of the drug.
To make 1 qt. of a 1:3000	solution use	5	grains of the drug.
To make 1 qt. of a 1:4000	solution use	3¾	grains of the drug.
To make 1 qt. of a 1:5000	solution use	3	grains of the drug.
To make 1 qt. of a 1:10,000	solution use	1½	grains of the drug.

PERCENTAGE SOLUTIONS (APPROXIMATE ONLY).

To make 1 dram of a 1% solution use	½	grain	(plus)	of the drug.
To make 1 dram of a 2% solution use	1¼	grains		of the drug.
To make 1 dram of a 4% solution use	2½	grains		of the drug.
To make 1 oz. of a 1% solution use	5	grains	(minus)	of the drug.
To make 1 oz. of a 2% solution use	9½	grains		of the drug.
To make 1 oz. of a 4% solution use	19	grains		of the drug.

N. B.—Occasionally 0.1-per cent. (1/10%) solution is required. In such a case make 1 dram of a 1-per cent. solution, and dilute it 9 times,—that is, add 9 drams of water.

Metric System.—This is so simple that every one should use it, although the long list of tables given in text-books for converting apothecaries' into metric measure, or vice versa, bewilders the average student. For practical purposes the following table is approximately correct:

METRIC SYSTEM.

Solids.	Approximate Equivalent.	Liquids.	Approximate Equivalent.
1 grain	0.065 gram	1 minim	0.06 c.c.
1 ounce	30. grams	1 ounce	30. c.c.
1 pound	500. grams	1 pint	500. c.c.
		1 quart	1000. c.c. or 1 liter

EXAMPLES.

To make 1000 c.c. (1 liter) of a 1:500	solution use	2	grams of the drug.
To make 1000 c.c. (1 liter) of a 1:1000	solution use	1	gram of the drug.
To make 1000 c.c. (1 liter) of a 1:2000	solution use	½	gram of the drug.

Thus remembering these approximate equivalents, you can at once produce a solution of any required strength; on the other hand, if the time-honored apothecaries' measure is used, a mathematical problem is practically necessary to gain the desired end.

Dusting-powders.—Among antiseptic dusting-powders may be mentioned *Boracic Acid,* a highly useful drug, for while it is only slightly antiseptic, it is many times less irritating than others of its class, and practically non-poisonous. It is a white, odorless powder (as used in surgery), and for this reason can be utilized where other dusting-powders would be objectionable. It is commonly used in solution as an antiseptic wash, but for it to have any antiseptic properties it should be a saturated solution (4 per cent). In the many operations on the eye it is practically relied on in the ante-operative preparation to cleanse that organ while in gastric lavage as a preparatory step to gastroenterostomy, it is universally employed; the urinary bladder is cleansed with irrigations of this drug when operations on that viscus are necessary.

Iodoform as prepared for surgical use is a yellowish powder, with a disagreeable odor. It is rich in iodin, and for this reason is extremely irritating to the skin, often producing a local eczema; nevertheless when it is used in suppurating cavities in the form of iodoform gauze, it has very beneficial results.

Aristol (Dithymoldiiodid) may be mentioned as a dusting-powder with similar action to iodoform. It is of a brownish-red color, less offensive, but has never supplanted the former.

Dusting-powders are not frequently used, because their presence is an irritant to the raw tissues; they form crusts, prevent the exit of any secretions from the stitch-holes and wound, and thus favor the formation of pus.

Abuses of Antiseptics and Germicides.—No class of drugs that has any connection with ante- or postoperative treatment of surgical cases has been so abused as those I am now considering. They are useful and necessary *in their place, and their place is limited. They are harmful and pernicious when used irrationally.* The *cleaner* a surgeon or nurse is by *instinct, the less will they use antiseptics;* the more *slipshod* they perform their duties, the more will they rely on these chemical agents. The *cleansing of an infected wound with a strong antiseptic solution never accomplishes the purpose for which it is employed, i. e., the sterilization of the wound,* because in infected wounds or cavities albuminous deposits and broken-down tissues are present which serve as a suitable culture-media for the propagation of microörganisms, and *beneath which the bacteria are sheltered.* The local tissues also have lost their normal power of resistance, consequently no barrier is interposed to the microörganisms penetrating this

semi-devitalized area, *remote still further from any effects of the antiseptic solution.* If the germicide be very strong and irritating, further necrosis is developed, more debris is formed, and still more devitalization of tissue occurs, so that instead of producing a sterile field, a fertile bed is being developed for the propagation of bacteria. The most an antiseptic solution accomplishes in the presence of infection is to remove in a mechanical way debris, blood-clots, necrosis, and such microörganisms as lay superficially, but *this can only be accomplished with a mild, non-irritating solution,* otherwise further necrosis and devitalization occur. *The greater the infection in wounds and other cavities, the milder should be the antiseptic used for irrigation,* but the larger should be the amount of solution employed. *Quantity* and not *strength* is the keynote. The lesson taught, therefore, is self-evident: the employment of mild, warm, non-irritating antiseptic solutions in large volumes, mechanically ridding the infected area of necrosis, and rejuvenating the underlying semi-devitalized tissues. On the other hand, strong antiseptic solutions are used to cleanse the hands of the operator and his assistants, and the field of operation.

The more that is known of antiseptics, and the more infection is studied, the more will *surgical cleanliness become the weapon against infection.*

Mechanical Antiseptics.—By the term "mechanical antiseptics" I intend to imply such measures as produce an antiseptic condition outside of chemical agents. The most common form is the ordinary *hand-brush* with *soap* and *water.* There are many surgeons today, probably the majority of them, who rely on this simple method mainly for the sterilization of the hands and the field of operation. A rather stiff-haired brush is employed with any kind of soap. I desire to impress on you the fact that it is not the *kind of soap* that will produce a sterilized condition of the hands or field of operation, but *it is the kind of methodical scrubbing with which the soap and brush are applied* to the parts.

The Sterilizing-room.—This should be a large apartment without any unnecessary furniture, easily accessible to the main operating-room; in fact, should communicate with it by a doorless opening to allow the surgeon or his assistants to pass to and fro without having a door to open and thus contaminate their surgical toilet. The floors of such an apartment should be tile, the walls enameled and so constructed as to leave no sharp corners with the floor or with each other. Woodwork must be dispensed with as far as possible, so that no crevices are left.

When such a room does not communicate with the operating-room it is a common occurrence to see nurses who have carefully sterilized their hands and assumed their gowns, passing backward and forward through the

corridors for necessary supplies. This is *wrong, slovenly,* and *careless,* for in a thoughtless moment their attire may be infected by coming in contact with visitors, nonsterile nurses, and patients. All furniture should be so

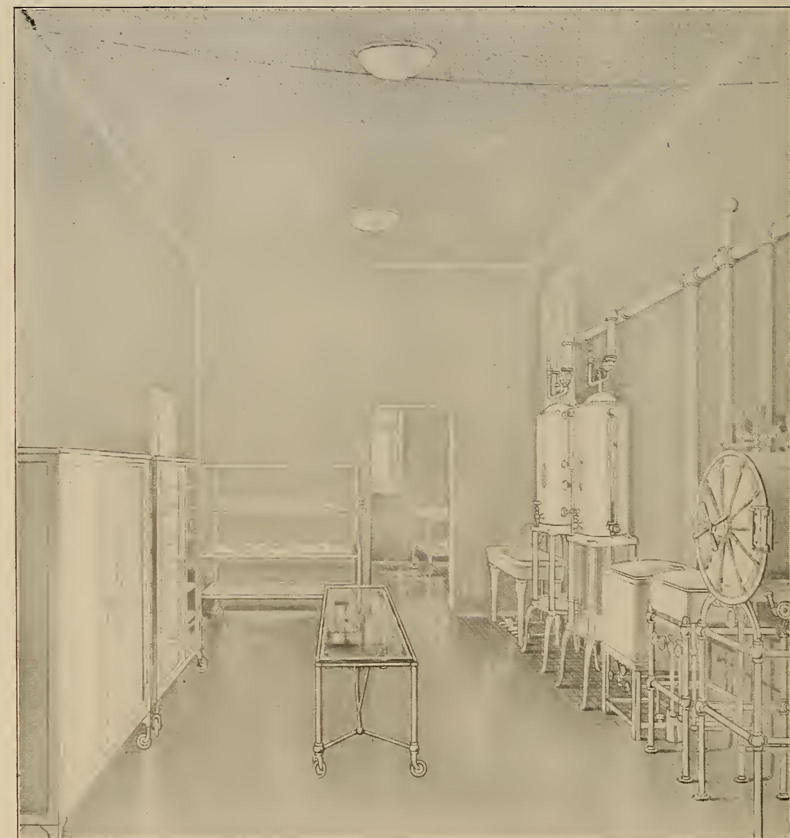

Illustration I

Sterilizing-room.—Observe the battery of sterilizers, porcelain sink, cupboards for dressings and instruments, and shelves for such medicines as are used in surgery. See illustration XLIII for the relation of this room to the operating-room.

constructed as to facilitate the cleansing of the apartment as thoroughly as the main operating-room. All cupboards for dressings and instrument-cases elevated on *six-inch* casters and of such height as to easily permit the cleansing of the top,—a location prone to collect dust. A satisfactory size

would be 5 feet 6 inches tall, 6 feet wide, and 20 inches deep, made of steel, enameled white, with movable shelves, glass doors and sides.

Necessary Furniture.—(1) A complete sterilizing outfit, connected with the boiler in the basement, for *water, dressings, pitchers* and *basins,* and *instruments.* This is so constructed that no superfluous steam is seen in the sterilizing-room. (See illustration I.)

(2) *A cupboard* for the storage of sterilized articles, such as dressings, sponges, gowns, suits, caps, gloves, etc. (The number of cupboards required for this purpose will vary according to the amount of surgical work performed in the hospital.)

(3) *An instrument case* for surgical instruments, needles, catgut, etc., unless a special room is devoted to instruments.

(4) *A porcelain sink* of suitable size elevated on metallic legs placed a sufficient distance from the wall to prevent an accumulation of debris, equipped with foot control of water faucets. This is utilized for cleansing the instruments after operation.

(5) *A four-shelf glass stand* on which is placed drugs and other paraphernalia commonly used in the surgery. This is the location of choice for such a piece of furniture,—not in the operating-room. The following is a partial list of supplies which should always be found on this stand:

Stock Solutions and Mixtures.—
- Stock Salt Solution.
- Saturated Solution of Boracic Acid.
- Evaporating Solution.
- Harrington's Solution.
- Iodin-Benzin 5-per cent. Solution.*

Drugs and Chemicals.
- Carbolic Acid.
- Lysol.
- Tincture of Iodin.
- Formalin.
- Mercuric Tablets.
- Oil of Turpentine.
- Alcohol.
- Hydrogen Dioxid.
- Tincture of Green Soap.
- Glycerin, Olive Oil, Vaselin, } Sterilized by boiling.

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* This solution is used by some surgeons in the final preparation of the field of operation. (See lecture on "Preparation of the Patient.")

Drugs and Chemicals.

Ichthyol.
Argyrol.
Silver Nitrate.
Ethereal Collodion.
Whiskey and Brandy.
Solution Adrenalin Chlorid.
Iodoform.
Aristol.
Boracic Acid.

Hypodermic Tablets.

Strychnin Sulph. gr. 1/30.
Morphin Sulph. gr. 1/4.
Morphin gr. 1/4 and Atropin gr. 1/150.
Atropin gr. 1/150.
Nitroglycerin gr. 1/100.
Hypodermic syringe and needles.

Local Anesthetics.

Cocain Hydrochlorid.
Eucain Beta.
Novocain Hydrochlorid.
Quinin and Urea Hydrochlorid. This last is only mentioned to be condemned, its after-effects produce sloughing of the tissues.

Gauze Preparations.

Iodoform gauze in small containers, 1 yard each.
Iodoform gauze-tape in small containers, 1 yard each.
Plain sterile gauze-tape in small containers, 1 yard each.

Accessories.

Urethral catheters (rubber and glass), assorted sizes.
Drainage tubes (rubber).
Colon tube.
Stomach tube.

These articles are sterilized and preserved in glass containers, filled with sterile glycerin.

One set assorted graduates.

Roller bandages, assorted sizes, kept in suitable containers.

Adhesive plaster in 10-yard rolls (12 inches wide), and spools of assorted widths.

Sterilization by Heat.—*By the term sterilization is meant the destruction of all bacteria in any given substance, generally by heat.* I would divide this process into three heads, viz.—

(1) Heat eliminated from live steam. { (a) Steam under pressure. (b) Steam without pressure.

(2) Sterilization by direct contact with boiling water.

(3) Sterilization by dry heat.

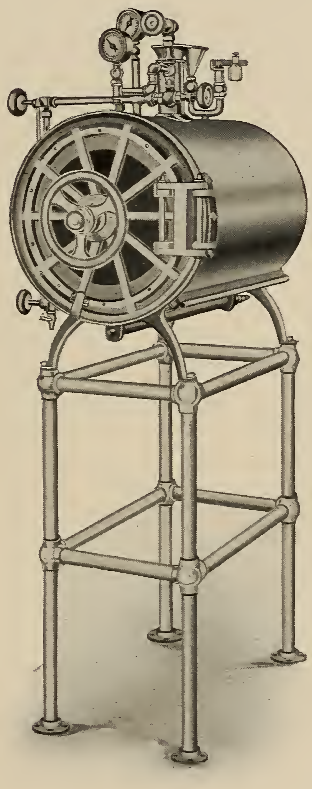

ILLUSTRATION II
Autoclave

Sterilization by steam under pressure is obtained at the present time in hospitals by means of sterilizers attached to the boiler-room, hence *it is steam under pressure,* and it is the best method of sterilizing dressings, gowns, etc., which are used in the operating-room. Steam under pressure

can be forced through all the crevices and layers of the material, and its effects are immediate as compared with dry heat. The time necessary for sterilization in live steam *under pressure* should never be less than *20 minutes,* and preferably *30 minutes.* (See illustration II.)

Such sterilizers are known as *autoclaves.* They will give a steam pressure of 10 to 15 pounds at about 250°F. The materials, after being sterilized, should be dry; if moist, it is due to a faulty mechanism in the sterilizer; this fault can be overcome by allowing the dressings, gowns, etc., to remain in the autoclave an hour or two after the steam has been turned off, the heat of which will consume the moisture.

Sterilization by Steam Without Pressure.—Occasionally you will be called upon to sterilize the different articles necessary for an operation at the home of the patient. A simple way to do this is to place two bricks edgewise in an ordinary wash-boiler in about two inches of water, place several strips of wood across these to form a foundation or bridge on which to rest the material for sterilization. Adjust the lid and place on the stove; *after the water boils* put in the materials for sterilization. This is not steam under pressure, hence the heat will not permeate as thoroughly and rapidly as in the autoclave. It is an erroneous idea to imagine that pressure of any consequence can be obtained in an ordinary clothes-boiler with a loose-fitting lid; *more time is therefore required.* Two methods are open for you to follow: (1) By sterilizing the materials for one hour, care being taken to watch the amount of water in the boiler. Or (2) repeat the above process the next day for a similar period. This latter method is known as *fractional or intermittent sterilization.* In both cases your dressings will be moist; by placing them in an oven the dry heat will absorb the moisture. The fractional or intermittent method has for its object the destruction of bacteria present at the time of the first sterilization; an interval of sufficient length (generally twenty-four hours) will permit any spores that may be present to develop, which are killed at the second or third sterilization.

Boiling Water.—This method of sterilization is still quicker than live steam. Dressings should never be sterilized in boiling water unless under the rarest conditions in private practice, and then they should be dried previous to being used. *Boiling water is the ideal means* of sterilizing *instruments, basins, and pitchers.* Sharp-edged instruments such as knives and scissors are not boiled, as this process dulls their edges. The time of sterilization in boiling water is from ten to fifteen minutes.

Dry Heat as a means of sterilization is not used in hospitals, but in private practice (especially in the country) the domestic oven is constantly called into service, not only to assist in sterilization but to dry such articles as have

been steam sterilized. It is *a poor substitute for any kind of steam;* the penetration of this kind of heat is slow; the liability of burning the fabrics great, nevertheless you will be called on to use it occasionally. The most thorough way is the *fractional method* spoken of above, but I would repeat the exposure of the materials to the heat for one-and-one-half-hour periods, with as long an interval as possible between such exposures.

In stating the time necessary for sterilization by the different methods, *I have purposely exceeded the limits usually laid down;* my experience in hospital practice warrants me in doing so. It is far better to err on the safe side, and be conservative, than be hasty and jeopardize the results of the operation.

LECTURE IV

ASEPTIC AND ANTISEPTIC SURGERY

Since I have spoken of antiseptics and disinfectants, it would be proper to call your attention to what is known as Aseptic and Antiseptic Surgery. By the term *asepsis is meant freedom from infection, "the absence of living pathogenic bacteria,"—surgical cleanliness.*

So that the modern acceptation of *aseptic surgery* implies an endeavor has been made to sterilize everything connected with an operation *previous to operating;* the hands of the surgeons and nurses have been thoroughly sterilized; the field of operation has been carefully prepared, possibly by means of *antiseptics;* the dressings, suture materials, and instruments have gone through a process of sterilization in an endeavor to maintain sterility of everything connected with the work. In spite of all this, it can probably be stated that there is *no such condition as perfect asepsis.* There is a limitation to our efforts along this line, and the most that can be accomplished is to render the bacteria present either harmless, or keep them in check to such an extent that the resisting force of the economy can overcome their virulence or number.

Once the operation has begun no *antiseptics* are used, because the first preparations are considered thorough enough to produce an aseptic condition. On the other hand an operation may be begun and all the details of aseptic surgery carried out to a certain point, when asepsis has to be relinquished, as in operations for pyosalpinx or suppurative appendicitis, where the presence of pus makes the use of antiseptic measures necessary in the further steps; *aseptic surgery* then gives way to *antiseptic surgery.*

By antiseptic surgery is implied that *germs have gained entrance into a wound and antiseptic measures are used, either to destroy them if possible, or reduce their virulence.* As an illustration, a patient with a wound is brought to the hospital; the logical inference is the skin is not surgically clean, nor the instruments or means by which the injury was inflicted sterile, hence, the wound is considered infected, and antiseptics are used to cleanse the parts. Antiseptic surgery is therefore practiced. To be concise, antiseptic surgery presupposes bacteria are present in the wound or field of operation and an endeavor is made either to destroy them or retard their growth

by antiseptics; whereas in aseptic surgery there is every reason to believe that the wound is clean and efforts are made to keep it so. You will soon discover the fact, when doing practical work, that *asepsis* and *antisepsis* go hand in hand, and very few operations are performed where both methods are not employed.

The numerous procedures utilized in the practice of aseptic surgery are called the "chain of asepsis," each individual step is known as a *link*. Surgeons and nurses should ever be on the alert to see that no link is broken, for remember "the strength of a chain is its weakest link": the thoroughness of asepsis is measured by its *weakest step*. Remember, too, the natural tendency is towards retrogression, unless the strictest care is exercised; nowhere is this more prone to show itself than in the routine of professional life. In hospital and private practice rules are laid down for the proper method to obtain the best aseptic conditions. So long as such rules and methods are carried out the results are gratifying. Sooner or later *this* or *that* trifling step is omitted, then another is overlooked, until the former perfect chain is weakened or possibly broken, so that *instead of an aseptic technic there is left only a septic routine.* This careless condition does not develop suddenly: it grows insidiously, until a high death rate or the prevalence of infection following operations, attracts attention. On close examination and inquiry into prevailing methods, some glaring errors which have stealthily crept in are discovered. *From the moment a surgical patient enters the hospital, or you are called to the home to render professional care, the strictest aseptic rules should obtain until convalescence is thoroughly established.*

Let me illustrate by examples which have come under my observation. In a hospital where I am more or less frequently called, I seldom or never operated but that infection developed before convalescence was established. This is the reverse of the results obtained at the hospital where the majority of my work is done, and I felt sure some faulty technic was responsible, yet, on going over the routine with the physicians and nurses in charge, no cause could be discovered for the untoward results that others and the writer were having. On one occasion I happened to overhear one of the senior nurses order a patient (who had just arrived) to adjourn to the bathroom and take a general bath before being put to bed. Being interested, I asked if all patients were so treated, and received an affirmative reply; further inquiry revealed the nature of the patient's illness to be one of *leg ulcers.* Without further comment I waited until the patient was put to bed, to see how the bathtub would be cleansed: *it was ready for use after being rinsed with warm water.* Later the soiled and pus-besmeared bedclothes from the bed of a patient suffering with septicemia were thrown in the bathtub to await the orderly whose duty it was to remove them to the laundry. I did not have time to see how the tub would next be employed, but I was now sure

the solution of my problem was in sight, and the cause of the numerous cases of infection discovered. It was horrifying and disgusting, possibly it would be nearer the truth to say it was criminal. A reform was instituted, the general bathtub abandoned, and the results from this time on were excellent.

It is just in this connection that I desire to emphasize a fact which I believe to be true: *hands that have become infected with pus remain so for three days, in spite of all the ordinary methods of cleansing, and whether they are or not, it is your duty to believe them infected; hence the employment of rubber gloves is compulsory.* Without the use of these articles infection can be carried from one to another, thus producing what I have already described as a *secondary infection,* a very serious complication.

An incident that goes to show how carelessness can creep in after ironclad rules have been established is the following: A patient was sent me from the southern part of Ohio to be operated on for gall-stones. She was ordered prepared for operation the next morning, and having occasion to visit another ward I noticed "Nurse A" cleansing a suppurative wound with *unglovcd* hands. It was not my patient, but knowing she was breaking a rule of the hospital in not wearing gloves while doing a dressing, I felt it my duty to call her attention to the infraction, but failed to do so at that time. I continued making my rounds until eventually I returned to the room of my patient for operation, when to my horror I discovered "Nurse A," who a few minutes before had been cleansing the suppurating wound, now preparing the abdomen of my patient with her hands still *ungloved.* On questioning her I elicited the fact that she was not using the *same basins* as in the suppurative case, and the only cleansing her hands had received was a little soap and water, and finally an immersion in a carbolic-acid solution. I may add the operation was deferred for three days, during which time the patient received careful antiseptic cleansing, and finally convalesced without any suppuration. The reverse might have been true if my attention had not been accidentally directed to this.

Moreover the omission of gloves in the nurse's technic, when dressing suppurative wounds, has caused primary infections in clean wounds of other patients, an illustration of which I desire to cite: A patient was suffering from an infected wound due to the presence of gonococci and staphylococci (mixed infection); the nurse was ordered to cleanse the infected area, which she did with *ungloved hands.* She was next directed to remove the coaptating stitches from *a clean abdominal incision of another patient,* and this she also accomplished *without the use of sterile gloves.* Three or four days later this patient developed an acute infection which resulted in suppuration. The microörganisms present were the same as in the first case. There being

no other infection on the floor, it was easy to trace the source of the infection and to see where the chain of asepsis was broken.

I hope I will not be considered tiresome if I cite another case,—similar incidents possibly occur daily in hospitals where the strictest supervision is not kept over the student nurses: A patient was to have a celiotomy performed the following day. It was late in the afternoon, and having to wait for a train, with nothing to occupy my time, I thought I would watch the day nurse prepare my patient. She went to the bathroom, filled two basins,—one with sterile water in which she put soap and brush, and the other with a solution of corrosive sublimate,—adjusted a pair of gloves, and repaired to the room to begin preparations. When asked how she knew the basins were sterile, she frankly replied, "They ought to be, they look so." On demanding to see the rules as laid down by the institution it was distinctly stated that all basins should be boiled before such preparations were made, but on account of the lateness of the hour this nurse had willfully or thoughtlessly overlooked this, and thus jeopardized the results of the operation. These innocent-looking receptacles are, unless sterilized, patent agents in the dissemination of infection.

I would not have you think the nurse is the only careless individual in hospital practice—far from it; some of the most glaring instances of dereliction can be placed at the door of those higher in authority. Let me cite some of the most common errors:

A properly equipped hospital should have closets in which are placed large galvanized iron pails (with fitted covers) as receptacles for the soiled dressings, etc. These closets should be used exclusively for this purpose, and not as storerooms for brooms and dust-cloths which are employed for cleansing the apartments. What good is obtained by fumigating an apartment for twenty-four hours with formaldehyd gas, and then use the dirty brooms from the "pus-closet" to sweep it? This is not the nurse's fault, it is due to the carelessness of the officials.

Another fertile source for a break in the chain of asepsis is the employment of damaged rubber gloves. It grates on one's sensibilities to witness a surgeon or nurse professing to be aseptic using these. They seem to think if the major portion of their hands are covered they are affording their patient ample protection.

Again, if it be necessary to devote a special room to the surgeon and his assistants in which to change their clothing, sterilize their hands, and gown themselves, why should not the same accommodations be granted the nurse? In other words, why should the surgeon have an aseptic room to prepare his toilet, and the nurse not have the same privilege, instead of being forced to retire to her *bedroom* to change her uniform and assume an operating gown? *Why should the surgeon consider it necessary to change his clothing first,*

then sterilize his hands, and finally gown himself, while the nurse is permitted or forced to assume her sterile gown before cleansing her hands? This break in the technic could be obviated by the use of a bib-apron assumed after the sterilizing process. The fault lies at the door of the officials whose duty it is to prevent such errors and inconsistencies. These examples are cited to demonstrate how easily the rules of asepsis can be broken; to demonstrate the necessity of keeping a strict watch over every detail concerning surgical patients; to suggest clues for possible trouble, and to demonstrate *that the aseptic patient is in constant danger of becoming septic.*

What is true of hospital routine is just as applicable to private practice, only from other sources. The most careful nurse can have her work go for naught by some member of the family immersing his or her dirty hands in the sterile water to ascertain its temperature, or through curiosity unfold a package of dressings or handle some sterilized instrument, thus breaking the chain of asepsis which has taken hours to consummate. So it behooves the nurse doing private surgical work, not only to do her work thoroughly, but also to insist that members of the family refrain from meddling with her duties. This can be done in a nice, cordial manner, so as not to offend, yet with a firmness that indicates her to be responsible for results in the absence of the surgeon.

I know of no place more appropriate than here to state that it is the surgeon's privilege to choose his own surgical nurse, when operating in private practice;—one who is well acquainted with his technic, one who appreciates his high ideals of asepsis—and not allow the family to dictate a nurse who is unacquainted with any of the special methods employed by the operator. It is unfair to the nurse, unjust to the patient, unsatisfactory to the surgeon, and above all, the results are generally imperfect.

In the lectures on "Preparation of Patient for Operation" and "Technic of the Operating-room," full details will be given as to the best methods to be employed to carry out a perfect chain of asepsis, and implicit instructions detailed as to each step, and the value of each procedure.

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LECTURE V

PREPARATION AND STERILIZATION OF GOWNS, SPONGES, DRESSINGS, AND OTHER ARTICLES COMMONLY USED IN SURGERY

Having tried to impress on you the necessity for asepsis and the dangers incident to any break in the chain of thorough cleanliness, I desire to go into details as to the methods employed in the preparation and sterilization of such articles as are kept ready for any emergency or contingency which may arise.

Gauze.—At the present moment this is used exclusively for sponges, dressings, and even bandages. It is soft and pliable; when utilized as a sponge or dressing it instantly absorbs any fluid with which it comes in contact.

There are variable grades of this material on the market, each having a different mesh. It is an erroneous idea when ordering to specify *by number,* as each maker has a different prefix to indicate the different grades, and frequently mistakes are thus made. The number of the fibers entering into a square inch of gauze will of course govern its mesh, and *this is the proper way of identification.* That is to say, gauze having 20 fibers running lengthwise in an inch, and 14 transversely, will give an open large mesh; while one having 36 fibers interlaced by 32 similar strands to the given space will produce a closer weave. The standard and recognized meshes are as follows: 14 by 20, 20 by 24, 24 by 28, 32 by 36, and 40 by 44. The 14 by 20 mesh is used chiefly for sponges as it absorbs more rapidly, while the 20 by 24 is the one utilized for dressings, its mesh being closer. Bandages are made from the 40 by 44 mesh.

Some hospitals after using their dressings and sponges laundry the same and utilize them again after being sterilized. While I have no doubt they can be thus made surgically clean, the thought is repulsive and should not be countenanced.

Gowns.—These are made from a good quality of muslin or preferably linen. There are various styles made to suit the taste and fancy of the individual, which of course is of minor importance from a practical standpoint. Whatever style is adopted, it should be full length with short sleeves to

which are attached sleevelets. I prefer this style, because should these latter become blood-stained, as is frequently the case, they can be easily changed during an operation. I could never see the philosophy of wearing rubber gloves and having the arms exposed, a locality where the epidermis is prone to be scaly in spite of all the preparation that may be given to the part. I may add in a well-equipped hospital the rubber gauntlet extending from the wrist to the elbow is used, but these are expensive and not durable, so a gown with extra sleeves tucked into the glove is perfectly satisfactory.

Gowns are prepared for sterilization by being laundered and incased in a folder or wrapper of muslin, *then in another folder of the same material,* the philosophy of these *double wrappers* will be appreciated when speaking of the technic of the operating-room.

Surgeon's Suit and Shoes.—The majority of surgeons remove their street clothing and attire themselves in white duck suits and canvas shoes before assuming their gowns. This is esthetic, in good taste, and necessary from an aseptic standpoint. The operator must have high ideals of asepsis; he should be the example of strict surgical cleanliness, towards whom his nurses should look for the latest and best thought, so that it behooves him to carry out every detail of a high standard. It is commonly urged that the spectators do not change their street apparel, simply covering the same with visitors' gowns, that they are capable of infecting the atmosphere of the operating-room. Inasmuch as they are remote from the field of operation, this source of infection is minimized. The surgeon's suit is sterilized at the same time as the gowns, and his shoes kept clean by the orderly of the institution.

Caps.—Some head-covering is necessary for both surgeon and nurse during an operation: there probably is no dirtier field on the surface of the body than the scalp. When one considers at least 75 per cent. of people are afflicted with dandruff, to say nothing of dust and other extraneous matter finding lodgment in the hair, some form of protection becomes compulsory. Some hospitals have caps ready made for the surgeon, while other institutions utilize two thicknesses of 20 by 24-mesh gauze as a turban, which is far preferable, because the constant laundering of the cap prevents its accurate fitting, besides it would be necessary to have many sizes on hand to fit the different surgeons. What is true of the covering for the surgeon's head is even more applicable to the nurse, her hair being long and more difficult to cover. A cap similar to what is known as a "dusting-cap" with a drawstring makes an efficient covering, but here too the gauze turban is very satisfactory when properly applied. Nothing mars the refinement of technic in an operating-room more than to see loose strands of hair falling from under the nurse's cap. This is a common occurrence, and impresses

the writer at once with the idea that if a nurse is careless to this extent during an operation where she is under observation, how far does her neglect extend in other lines of duty? Caps are prepared for sterilization by being folded in double wrappers together with the face-masks, if these are to be used.

Face-masks.—Some surgeons use a covering for the entire face, with the exception of a large opening for the eyes. I can easily understand in case the surgeon has an acute tonsilitis or pharyngitis or is afflicted with ozena, the field of operation should be protected from the exhalations by some face covering. It is also appropriate for those operators who have growths of hair on their face to wear some form of protection. From a careful observation I think I may say that the majority of surgeons do not use the mask. If such masks are utilized they are sterilized with the caps; frequently, however, they are made by enveloping the face, with the exception of the eyes, with a 20 by 24-mesh 2-ply gauze.

Nurses' Aprons.—These are made from the same material as the operating-gowns, and are of the pattern commonly known as a "bib-apron," being suspended around the neck with a tape and a similar means for fastening around the waist. These are preserved in double wrappers and sterilized.

Gauze Sponges for Use in the Operating-room.—It would be impossible to describe the various patterns of sponges used by different operators. Some are useless to the practical surgeon, while others are too complicated and consume too much time in construction. Whatever kind of sponge is decided on *remember that no raw edges must be in evidence.* They must be folded and invaginated so that when ready for use no raveling or fiber of the material will be apparent, because these little particles if left in the wound will prevent healing and at times occasion suppuration. Three sizes of sponges are generally used.

Small or Wipe Sponge.—These are used exclusively for cleansing *external wounds,* and measure 3 by 5 inches when folded and ready for use. The following description will give you an adequate idea of how they are made: Take a piece of gauze approximately 10 by 17 inches having a selvage on one of the narrow ends, lay flat on the table, fold the selvage to within two inches of the opposite side; then fold it in half; take one end of the material and fold within two inches of its length; again fold the piece in half; you will then discover you have made a pocket which you will turn inside out, thus forming a second pocket, which is again treated by infolding. The sponge is prepared and all raw edges are within. It is better to use this kind of sponge for all newly made or fresh wounds than the *ordinary cotton-*

ball sponge, because of what I have stated, the liability of leaving some fibers in the wound to cause unpleasant results. These articles are preserved in double wrappers and sterilized.

Abdominal Sponge.—These are used exclusively in the abdomen. The average size when completed is 12 by 34 inches, and is made by cutting the gauze in yard lengths and folding one selvage one-third across the width of the material and lapping the other over this, thus we have the gauze folded lengthwise in three ply. Stitch across each end, in this way forming an oblong pocket; turn this inside out, making a second pocket; again invaginate this, and all raw edges will be concealed. I do not think it necessary to attach a tape to a corner of these sponges, as is done in some hospitals, to prevent their being left in the abdomen, because they are of sufficient size to be easily found. The tapes with hemostats attached are constantly interfering with the different manipulations that are taking place through the abdominal wound. Besides, if a careful method is instituted in counting, no sponges will be overlooked in the abdomen. When such an accident occurs you may rest assured it is due to a slipshod manner of preparing dressings in hospitals where there is no thorough method, or if rules have been established they have been modified or changed to suit the whims or fancies, or to lessen the duties of the nurse in charge.

I have no patience with anyone who is careless, and if at any time the most thorough and careful attention to duty is needed, it is where human life is at stake. Nothing should be too laborious to preserve thoroughness of technic, nothing should be considered too trifling, if it adds one "jot or tittle" toward perfection.

The large Abdominal Sponge or Towel, as it is termed, is made exactly like the above, only in three-yard lengths. They are not often used, excepting in large pendulous abdomens, or where the bowel is very distended, in which cases they are more satisfactory to retain the intestines in the desired position than the smaller variety. The necessary number (generally three in a package) is prepared for sterilization in the same manner as the abdominal sponge, and is counted by the same method.

I do not think it necessary to have *any special size sponge for appendectomies,* because if there is no suppuration and a small incision is made no sponges are needed, and if there is suppuration it is necessary to make a sufficiently large incision to facilitate the placing of sponges so as to wall off the field of infection previous to any manipulation; in such cases the ordinary abdominal sponge answers admirably.

Complications arise the moment the accessories are multiplied. This applies to sponges as well as to numerous and complicated instruments for

operating, and the surgeon or nurse who can accomplish thoroughly a given object with the simplest technic will have less chance for sepsis creeping in than those who use twice the number of supplies.

Preliminary Count and Record of Sponges.—Having the sponges made of the required size, the necessary number (generally 14 in a package) *is counted by the chief operating-room nurse, and re-counted by her assistant;* they are then put in double wrappers; on the outside cover is stamped in indelible ink, *"abdominal sponges," followed by a number.* A book is kept with the following data: *package number, number of sponges, date sponges were sterilized and counted,* and a *blank space for the signatures of the head nurse and her assistant who are required to sign their names.* Thus the sponges have been counted twice so far; by carefully following the routine these articles go through, you will discover they are counted *six times before the abdomen is closed,* and that too without the slightest extra work.

I could mention several most deplorable accidents which have followed in the wake of the careless counting of sponges, and in order to impress on your minds the responsibilities which rest on you I will crave your permission to cite one case: One of the most brilliant physicians of Central Ohio developed appendicitis, and following out the Biblical adage that a "prophet is not without honor save in his own country," he traveled miles to obtain what he considered the greatest expert in the world to operate. After lingering weeks the patient died. The autopsy revealed a gauze sponge left in the abdomen! The operation was performed at one of the best hospitals in the country, the surgeon was one with but few peers in his profession,—but as I have said, the strength of the most perfect technic lays in its weakest procedure. The *carelessness of some one* was responsible for robbing the profession of one of its most brilliant representatives. Can you realize now that the surgeon's reputation is more or less in his nurse's hands, and that the responsibilities resting on the nurse are so great that only those of the highest type of character should be permitted to enter our training-schools?

Dressings for Use in the Operating-room.—*Plain Sterile Gauze Dressing,* or as it is known in hospital vernacular, fluffy gauze.—The material is cut in twelve-inch squares, edges left raw, about 36 ply, which is a sufficient amount for an abdominal section or for any major operation.

Cotton-gauze Dressings.—To make this combination, *which is used in connection with the fluffy gauze,* the ordinary absorbent cotton that comes in pound-rolls is cut crosswise in 12-inch strips, doubled on itself, and then covered with two-ply gauze; the gauze being sufficiently large to admit of the infolding and stitching of its edges. Two of these will cover the twelve-inch fluffy-gauze dressings. This combination makes a soft protective, is

neat, and far preferable to the loose cotton laid on the gauze which is commonly seen. These are preserved in double wrappers together with the plain dressings and sterilized the necessary length of time.

Abdominal Outfit.—By this term is understood a package containing the necessary amount of fluffy gauze, cotton-gauze combination, together with *an abdominal binder* or *Scultetus bandage* which will be described under the section devoted to "Bandages." This outfit is preserved in double wrappers and passes through the usual process of sterilization.

Medicated Gauze.—I desire to call your attention to the two principle forms of medicated gauze, viz., Sublimate and Iodoform.

Sublimate Gauze is simply the ordinary gauze soaked in a solution of bichlorid of mercury of desired strength and then dried. It is not employed to the extent it was in former years.

Iodoform Gauze is a sterile gauze saturated in a mixture of iodoform, ether, alcohol, and glycerin. The different pharmaceutical houses make this form of gauze very satisfactorily, so that you will be rarely called upon to make it. The disagreeable odor produced during its preparation permeates everywhere; however, some large hospitals prefer to manufacture it. Under such circumstances it can be made as follows, bearing in mind every *step must be thoroughly aseptic,* because when prepared it should not be sterilized:

(1) The gauze is cut in one-yard strips and carefully sterilized in the autoclave in the same manner as other dressings.

(2) The nurse cleanses her hands, adjusts cap, gown, and two pairs of rubber gloves as though she were preparing for a celiotomy.

(3) Sterilize the following articles: 1 basin, 1 spatula, and 1 pair of dressing forceps.

(4) Have the following ingredients at hand—

Iodoform Powder .... ℥ 6
Glycerin ....pt. 1
Alcohol .... ℥ 8
Ether .... ℥ 8—HAUBOLD.

(5) Carefully mix the iodoform and glycerin into a smooth paste with the spatula, add the alcohol and finally the ether.

(6) Remove the double wrappers from the sterile gauze and discard the outer pair of gloves.

(7) Emerse only as much gauze as will be thoroughly permeated with the mixture.

(8) Fold a single layer of the gauze to a convenient size and preserve in small sterile glass jars, capable of being hermetically sealed. I prefer this

material kept in amounts sufficient for one dressing, instead of having large quantities stored in one container and removed therefrom as occasion demands, *as in this way contaminaton is invited.*

The plan of keeping this gauze in sterile towels and oiled silk as advised by some authors is impracticable, because the odor permeates all other dressings with which it is stored. Under such circumstances the plain gauze is as odoriferous as the medicated article.

Illustration III

Tape or Gauze Packing.—Note the raw edges are not in evidence, and the size of the container.

Tape or Gauze Packing.—This is made from a piece of gauze three inches wide and two yards long, so folded that no raw edges are apparent. To accomplish this infold the raw edges towards the center of the entire strip, then fold the same on itself and you have four-ply gauze about three-fourths of an inch wide. (See illustrations III and IV.) This is made from *either plain* or *iodoform gauze;* if from the former, it is placed in heavy-glass test

tubes, the mouths of which are closed with cotton over which is tied a two-ply piece of 20 by 24 gauze; these are then placed in the autoclave with the other dressings for sterilization. If made from iodoform gauze the strictest aseptic precautions must be taken, as this material should not be sterilized by heat, *in spite of whatever may be said to the contrary.* It is best kept in similar sterile glass containers as recommended for the plain-gauze tape.

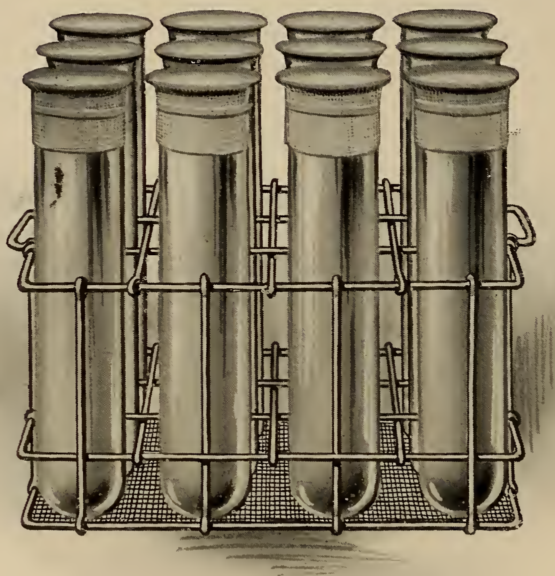

ILLUSTRATION IV

Tape or Gauze Packing preserved in test tubes and ready for sterilization.

For all ordinary cases such a package will contain a sufficient amount of either dressing.

Oiled Silk, Rubber Dam, Gutta-percha Tissue.—These materials are used to protect the dressings in the case of suppurative wounds, gall-bladder operations, etc., or where it is necessary to maintain a moisture within the dressings, as in skin grafting. They are kept in stock in their original packages; when needed a suitable piece is selected, thoroughly washed in

soap and water, rinsed, and placed in mercuric solution 1:2000 for *not less than ten minutes;* before being used they are again rinsed.

Gloves.—After having passed through the gantlet of criticism and withstood the most bitter arguments that any surgical accessory has ever met, these useful articles are now a fixed part in the technic of a modern surgeon and nurse. They are as much of a necessity as the anesthetic, the scalpel, or the scissors, and the surgeon or nurse who omits their use is derelict in duty. Experiments have shown that with the usual methods of hand sterilization, less than three per cent. are sterile. Reference has already been made to the necessity of wearing gloves when doing dressings. Gloves are

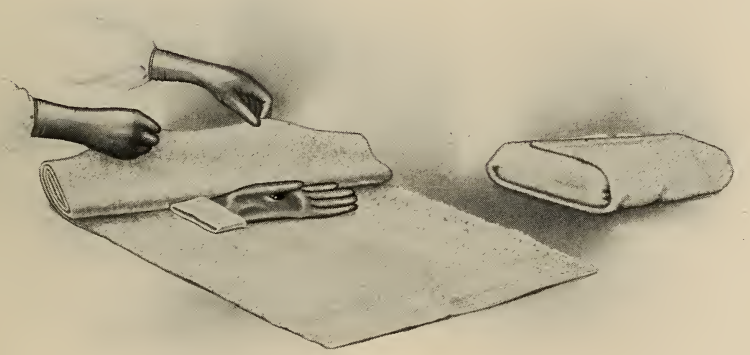

Illustration V

Sterile Gloves, wrist folded outward, powdered, and preserved in sterile towel. Note the care exercised by having the hands gloved during the preparation.

essential also in vaginal and rectal examinations. It is hardly necessary to mention the fact that they come in various sizes, so that it behooves the operating-room superintendent to be acquainted with the different numbers necessary to fit the surgeons, assistants, and nurses. Too small a glove destroys the tactile touch by excessive pressure, and one too large interferes with dexterity.

Care of gloves after being used.—

(1) Wash thoroughly inside and out with soap and water.
(2) Balloon with air to ascertain if damaged by needle punctures, etc.
(3) Discard all imperfect gloves.
(4) Sterilize by one of the following methods:

Sterilization of Gloves—Method One.—

(a) Boil for five minutes.

(b) With *sterile-gloved hands* place the gloves between *sterile towels and thoroughly dry inside and out.*

(c) Assort and powder, inside and out, with *sterile* talcum powder.

(d) Fold the wrist of the glove outward, thus forming a cuff; this is highly important to facilitate the adjustment to the hands later.

(e) Preserve by separating each pair in a fold of a sterile towel.

(f) Thus a roll is formed, each fold containing one pair of gloves.

(g) The ends of the roll are folded toward the center and pinned. An outside wrapper is then applied. (See illustration V.)

Method Two.—

(a) Dry thoroughly inside and out after carefully cleansing.

(b) Assort and powder inside and out.

(c) Fold the wrist of the glove outward to form a cuff.

(d) Separate *each glove from its fellow by a two-ply layer of gauze.*

(e) Preserve in folds of a towel in the manner described in method one.

(f) Place in the autoclave and sterilize with the dressings, etc., for five to eight minutes.

Both of these methods are efficient. The process of boiling as described in the first method should be employed when infection has been encountered during an operation. The weakest link in this method is the liability of contamination in the final steps. The second method is sufficiently thorough for all practical purposes when infection has not been present. It possesses the advantage in that the gloves are not handled after being sterilized. *In both methods the gloves are dry when needed for use*—a great step in advance in glove sterilization.

Adjustment of gloves to the hands.—

(1) Powder the hands thoroughly with sterilized talcum powder.

(2) Grasp *the cuff of the glove,* insert the fingers and pull into place. The ease with which this is accomplished will surprise those unacquainted with this method.

(3) After both gloves are adjusted, turn back the cuff,—in this way the outside of the glove has not been touched by an ungloved hand. The hands of the surgeon and nurses are kept dry all through an operation. (See illustration VI.)

Method Three.—

(a) Envelop the gloves in a towel.

(b) Boil with the instruments at the time of the operation for five minutes.

Illustration VI

Manner of adjusting gloves. Observe the outside of the glove is not touched when the adjustment is made as has been described.

When prepared in this manner it is necessary *to fill the glove with water before it can be adjusted—this process keeps the hands moist throughout the operation and produces a maceration of the skin similar to that seen on*

the hands of a laundress. Again, the naked hand is frequently used to assist in the adjustment of the *first glove* and hence may deposit some infectious material on it.

Talcum Powder.—This homogeneous powder is mentioned in connection with rubber gloves because it facilitates their adjustment when used dry. It is kept in cans with perforated tops and extra lids, or in small glass jars covered with two-play 20 by 14-mesh gauze, so that it can be easily dusted without opening the container. It is sterilized for the usual length of time in the autoclave with the dressings.

Towels.—An ample supply of these should be kept in stock and ready for use at a moment's notice. They are made from a good grade of bleached toweling, cut in one-yard lengths and *laundered before being used.* Those intended for the operating-room are placed in double wrappers, twenty-four to a bundle, and sterilized.

Operating-table Pads.—Because of the objectionable symptoms which arise when a patient is caused to lie on a hard cold surface for any length of time, it is necessary to cover the top of the operating-table with suitable pads. These are composed of cotton wadding incased in muslin and quilted. Before being used on the table they are enveloped in a rubber cover and then in a sterile muslin slip. This latter is removed after each operation, laundered, and sterilized.

Blankets.—There are various ways of keeping the patient warm during an operation. In some hospitals they prepare what is known as a chest protector. It is made similar to an ordinary "pneumonia cotton jacket," only in a more substantial manner, so it can be used repeatedly. I much prefer two small blankets, one to cover the thorax, and the other the lower extremities. These are more easily removed after an operation than any other cover, besides if a chest protector is employed it will still be necessary to use a blanket for the limbs. These blankets need not be sterilized after being laundered inasmuch as they are carefully covered by rubber sheeting, sterile towels, and celiotomy or other sheet.

Rubber Sheets.—Several of these must be kept in stock. They are used to protect the blankets and keep the patient dry. They are especially necessary with those operators who use a *double preparation.* (See lectures on "Preparation of Patient for Operation" and "Operating-room Technic.") These rubber sheets are kept sterile by being thoroughly scrubbed in soap and water, rinsed, and immersed in bichlorid of mercury solution 1:2000 and dried.

Celiotomy Sheets.—These are designed from a good quality of muslin sheeting, two-and-one-half yards square, with an oval aperture 9 by 6 inches, so placed as to correspond with the field of operation. This acces-

sory makes a nice covering for the blankets, etc., with which the patient is surrounded during an operation, as well as for the table which it practically conceals. These are kept in double wrappers and pass through the usual process of steam sterilization.

Ward-service Dressing Outfit.—Double-wrapped packages containing the following articles are sterilized and kept in stock *for use in the ward:*

(1) 1 dozen cotton-ball sponges.

(2) 12-ply fluffy gauze. (The usual 12 by 12 inches.)

(3) 4 towels.

This combination is simple and contains all that is necessary for an ordinary plain dressing.

Ligatures and Sutures.—*A Ligature is some means employed for tying, while a Suture as applied to surgery is some material used for stitching.*

The materials used for sutures and ligatures may be divided into two classes, (1) the absorbable, and (2) nonabsorbable. Among the former can be mentioned catgut and kangaroo tendon, while among the latter may be classified silk, pagenstecher or celluloid linen, silkworm gut, horsehair, and wire. You will note from this that all animal sutures are not necessarily absorbable. A perfect suture or ligature should have the following qualities:

(1) Nonirritating to the tissues.

(2) Be capable of sterilization, being made antiseptic, and retaining this latter quality until absorbed.

(3) Of sufficient tensile strength to accomplish the purpose for which it is used.

(4) Pliable so that it can be easily handled, securely tied, and remain so.

(5) Absorbable so that it can be buried in the tissues and not have to be removed.

(6) Durable, so that its longevity will be sufficient to accomplish the purpose for which it was intended.

Catgut.—This material seems to fulfill all of these purposes better than any other. No one seems to know from whence the name originated, and as that is of no practical value I shall omit the different opinions that have been advanced. It is obtained from *the connective* tissue of the sheep's intestines, preferably from the European animal, as the quality of this gut seems to be of a higher standard.

It is peculiar that even at the present time there is a controversy as to what part of the intestine is really employed in the manufacture of the surgical article. Dr. W. S. Halsted of Johns Hopkins University, Balti-

more, I think maintains that the submucous layer (connective tissue) is the one which is utilized. Dr. A. D. Whiting of Philadelphia, in a series of microscopical examinations confirms this statement and concludes thus: "Every strip that I examined was prepared by this method [a method spoken of in his article] and every one showed the same structure, viz., a fibrous reticulum, probably the connective tissue of the intestine." To this latter physician I am indebted for many useful suggestions that will be found in this connection.

There is one fact that should always be borne in mind in the preparation of this material for surgical use: *"catgut is dead animal tissue, therefore a good culture-medium for microörganisms;"* hence it must not only be sterilized, *but made antiseptic.* If only sterilized, it forms an excellent propagating-bed when in contact with bacteria; to obviate this it should be rendered antiseptic as well, and *retain this property during the process of its absorption.*

ILLUSTRATION VII

A Tube of Catgut. The proper container in which to purchase this material.

Sterilization of Catgut.—There are numerous ways advocated for its sterilization, so numerous indeed that one is convinced of the imperfections of all; whenever there is a multiplicity of remedies for a given disease you can rest assured the results obtained are not what is desired, and so it is with the sterilization of this article. Some hospitals prepare catgut from the crude material, others buy it in hermetically sealed tubes ready for use.

I am fully convinced that the manufacturers are furnishing a product which is as good as any that can be had at the present time; and in individual containers, it is preferable to the home-made article. There are three varieties on the market, the *plain, chromicized,* and *iodized.* The plain will remain in the tissues from seven to ten days before being absorbed, while the chromicized has a life history of twenty to thirty days, the longevity of which depends on the length of time the gut is soaked in a solution of bichromate of potash. Both varieties come in the standard sizes, namely, 00, 0, 1, 2, and 3. (See illustration VII.)

With the kind permission of Dr. Willard Bartlett (the originator) of St. Louis, Missouri, I append the simplest and at the same time the most perfect

routine that has been brought to my attention for the sterilization of catgut in iodin:

"(1) The strands are cut into convenient lengths, say thirty inches, and made into little coils about as large as a silver quarter. These coils in any desired number are then strung like beads onto a thread so that the whole quantity can be conveniently handled by simply grasping the thread.

"(2) The string of catgut coils is dried by hot air for four successive hours at the following temperatures, 160 F., 200 F., and 220 F., the changes in temperature being gradually accomplished, care being taken that the catgut does *not* touch metal or glass.

"(3) The catgut is placed in liquid albolene, where it is allowed to remain until perfectly 'clear,' in the sense that the term is used in the preparation of histological specimens. This is usually accomplished in a few hours, though it is my custom to allow the gut to remain in the oil over night.

"(4) The vessel containing the oil is placed upon a sand bath and the temperature raised during one hour to 320° F., which temperature is maintained for a second hour.

"(5) By seizing the thread with a sterile forcep the catgut is lifted out of the oil and placed in a mixture of iodin crystals one part, Columbian spirits (deodorized methyl alcohol) one hundred parts. In this fluid it is stored permanently, and is ready for use in twenty-four hours; the thread is then cut and withdrawn.

"It seems to me important that the gut should be thoroughly 'cleared' before the oil is heated, in order that we may be thus certain that the temperature of the center of the strand becomes as high as that of the oil outside. It may be noted further that I do not remove the oil from the gut before placing it in the storing solution. This is done purposely, since catgut which is perfectly free from oil, is so very sensitive to the action of water that it readily untwists and becomes tangled after it is used in a *wound* but a few moments. This storing fluid simply takes off enough oil from the exterior of the strand so that it is not too slippery for use, and the albolene being a bland, non-irritating substance, there is no reason why it cannot be safely left in the gut. The iodin rapidly permeates the strand; the same will be found stained black after a few hours, and consequently the surgeon will have the assurance that he is introducing an antiseptic as well as a thoroughly sterile suture material."

You will note in the above procedure that the temperature is brought to 320° F., which is *far above any temperature necessary to destroy bacteria.* It is made *antiseptic by being submerged in a 1-per cent. iodin-alcohol solution.* The author names some of the best surgeons of the country as being advocates of his method. I have gone somewhat fully into the details

connected with this material, because it stands out as the favorite American suture and ligature, being used in this country to a greater extent than elsewhere.

Kangaroo Tendon is obtained from the Australian animal bearing that name; it practically has been displaced by chromicized catgut. It is occasionally used in holding the fragments of a fractured bone together.

Silk.—This material is being less used daily for several reasons: (1) It absorbs tissue fluids into its meshes and thus becomes a favorite culture-bed for bacteria; (2) being nonabsorbable it sooner or later becomes an irritant and therefore should never be used in buried tissues. Its field of usefulness was formerly in intestinal work, but it has been supplanted by pagenstecher. Silk is sterilized by being boiled. Some operators then submerge it in 1:2000 mercuric solution, the object of the last step being to add an antiseptic quality to the material. It comes in various sizes (00 to 10, catgut gauge), and in two forms, white and iron dyed,—the latter being black makes it more visible for removal.

Pagenstecher is linen thread coated with celluloid.—This coating forms practically an impervious protection and at once overcomes some of the objections to silk. Its tensile strength, too, is greater, so that a much finer thread can be used,—another commendable feature, especially in intestinal work. It is sterilized by being boiled.

Silkworm Gut.—To obtain this the worm is killed just about the time it is to spin its cocoon. It possesses high tensile strength, and is practically impervious to moisture. It varies somewhat in size. Some surgeons use it exclusive to all other material for closing incisions of the skin, while others on account of its impermeability employ it in vaginal operations. It is easily sterilized by being boiled with the instruments at the time of operation.

Horsehair, as the name implies, is obtained from the tail of that animal. This material has long been used by the profession for sutures. There was a period in which it fell into disuse to a great extent, but within the last few years it is again occupying a prominent position in certain classes of work. It is impermeable to moisture, the strands are very fine, can be armed with small needles, and are of fairly high tensile strength, more easily tied and more pliable than silkworm gut, hence you can appreciate the excellent purpose it serves in cosmetic surgery of the face and mouth. It comes in hanks of about one hundred strands and is sterilized by boiling, after being thoroughly washed in soap and water.

Wire.—There are three varieties of wire used,—annealed iron, silver, and gold. I have mentioned them in the order of their usefulness. Their

sphere is very limited, being at the present time used chiefly to approximate fragments of bone. To do this the wire must have a fairly good tensile strength and be sufficiently flexible to be twisted without breaking, all of which properties the iron wire possesses to a greater extent than the softer metals. I may add that annealed wire, as demonstrated by the radiograph, when used in bone surgery is occasionally absorbed, which certainly would not be the case with the other two. Sterilize by boiling.

Drains.—In the last few years drainage has simplified itself so that the complex mechanisms that were formerly used have been entirely abandoned. The facts are, very few drains accomplish the purpose for which they are made. The various forms of glass drainage tubes are a matter of history among modern surgeons. At the present time, the cigarette drain, the Mikulicz drain or tampon as it should be termed, and rubber tubes of different calibers are utilized.

The cigarette drain is made by rolling an open-mesh gauze (14 by 20) into a loose wick and covering the same with rubber dam or gutta-percha tissue, leaving the gauze projecting at both ends. The length of this drain will depend upon the depth of the cavity in which it is to be used. They are generally prepared in twelve-inch lengths, packed in test-tubes properly stoppered and sterilized. Before being used they should be moistened in sterile water to hasten capillary attraction. Theoretically iodoform gauze should not be made into a cigarette drain, inasmuch as the drug fills the meshes of the gauze and is supposed to prevent capillary attraction; however, this medicated gauze is frequently used in this way.

The Mikulicz tampon is used chiefly as an intra-abdominal compress, where there is persistent oozing of blood, or where large areas of necrotic tissues are left. The tampon is made by invaginating a sufficiently large square of iodoform gauze through the abdominal wound so as to permit its distal extremity to protrude through the incision, thus forming a pouch, which is then filled with plain sterile gauze to produce the necessary compression. Thus there is a sufficient amount of iodoform to act as an antiseptic and retard bacterial growth and yet not enough to produce deleterious effects by excessive absorption, while the sterile gauze acts as the compressing agent. These tampons are not kept in stock, but are constructed by the surgeon as needed.

The Rubber Drainage Tube is made from the best para rubber. Several sizes should be kept on hand to meet the necessities of the individual case. To prepare them for use the proximal extremity is cut wedge shape and the sides of the tube fenestrated so as to allow a free exit for fluids. They are used chiefly in gall-bladder operations and in amputations of the

extremities. An assortment of these articles should be kept sterilized and preserved in sterile glycerin in glass containers to be ready for use when needed.

Bandages—Roller.—These are made from various materials, but those manufactured from 40 by 44-mesh gauze have so far superseded muslin and other fabrics, that I shall call your attention principally to this variety. They are made in different widths, from one to four inches, and generally ten yards long.

It is poor economy and far from practical to take the time of a nurse to roll gauze bandages, because they can be purchased in any size from the manufacturers, sealed in paper covers, and are sufficiently sterile for all practical purposes, inasmuch as they do not come in contact with the field of operation and are only handled by the surgeon and nurse after the operation is completed and the dressings are in place. Muslin should no longer be recognized as a proper material from which to make roller bandages; it is not as flexible, nor as pliable as gauze, does not conform to the parts with the same facility as the lighter material, and keeps the part warmer than the more open-mesh substitute. However, at times a small amount of elasticity is desired in a roller bandage. In such cases they are made from flannel of the desired width and length. The field of usefulness for such a bandage is in cases of phlebitis, especially of the lower extremities, where the object is to produce a slight elastic compression on the veins and utilize evaporating lotions, which would not be possible if a rubber bandage were adjusted. In varicose veins, however, such a bandage is not to be compared with the elastic stocking.

I do not propose to give you the various ways and diagrams, which *have been handed down as heirlooms, on bandaging.* The application of a bandage is an art which is acquired only by practice; in fact, at the present time the average surgeon follows no classic rules or patterns in applying bandages, his single thought and whole purpose being to have the dressings kept in place by the simplest method, without causing any irregular or undue compression.

For convenience in describing a bandage it will be divided into *"the initial end, which is within the roll, the body or rolled part, and the terminal end."*—DaCosta.

General Rules for the Application of a Roller Bandage.—In applying a bandage, place the outer surface of the terminal end on the part and work upwards, making an equal tension on each turn. Frequently in adjusting a bandage you will notice the turn or lap does not conform snugly to the contour of the part; to overcome this, make what is known as *the reverse* by holding the roller in the right hand, start the bandage obliquely upward,

place the index finger of the left hand at the point which will correspond to where the new turn is about to begin, keeping the roll very slack, fold the bandage downward from the point of the index finger, encircle the part, and *then increase the tension;* this may seem simple but it will require practice to accomplish it dexterously.

When approaching an articulation a *figure-of-eight* turn should be used, which may be described as follows: Beginning on the outside of the member and below the joint pass upward and inward to a point well above the joint; carry the bandage underneath the member to a point external to and above the articulation, thence over the anterior surface to a location internal and below the joint, pass beneath the member to the point externally from which the "figure-of-eight" was begun; repeat these various steps covering two-thirds of the previous turn of the bandage until the joint is completely incased.

As a rule the amateur uses too wide a bandage. Bandages for the finger should not be over an inch wide, for the hand and arm two inches; the same is applicable practically to the lower extremities, the toes requiring about an inch bandage, the foot and leg a two-inch roller, while the thigh will possibly demand one of three inches in width.

A Scultetus Bandage, also known as an *abdominal binder or many-tailed bandage,* is usually made by taking a piece of cotton flannel twelve inches square and stitching across it strips three and one-half inches wide by thirty-six to forty-eight inches long in such a manner that each piece overlaps the succeeding one about half its breadth, shingle-fashion so to speak—leaving free ends on either side. All edges must be hemmed to prevent raveling. Two or three different sizes should be kept always on hand. This is a very useful bandage, being not only applicable after abdominal operations, but in surgical procedures on the thorax such as amputations of the breast, etc. I may add that instead of using the ordinary canton-flannel abdominal binder after celiotomies, when ether or chloroform has been the anesthetic or where vomiting is liable to occur, I employ an extemporized binder made as follows:

(1) Cut from a roll of adhesive plaster twelve inches wide a portion sufficiently long to encircle the abdomen and allow a lap of four to six inches.

(2) Place the plaster evenly under the patient.

(3) Remove the crinoline protective from each end to a point that corresponds to the width of the patient's back.

(4) Cut each end into four equal strips.

(5) Apply each strip by overlapping alternately over the abdomen in the same manner as any other many-tailed bandage.

Advantages of this Bandage.—

(1) It acts as a splint to the traumatized abdominal wall.

(2) It gives firm support in postoperative vomiting, or coughing, the result of bronchitis or pneumonia.

(3) It retains its position and prevents the patient from interfering with the dressings below.

In this connection I cannot refrain from mentioning a case of gangrenous appendicitis on which I operated. The subject was a lad of nineteen. The operation was performed about noon; near midnight of the same day the

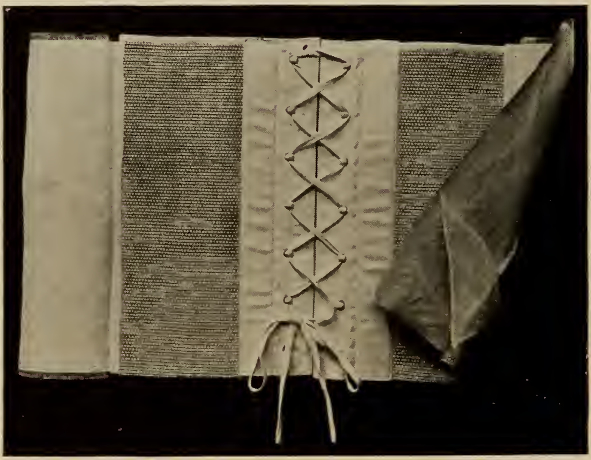

ILLUSTRATION VIII

A simple retaining Abdominal Binder. Useful and practical for retaining abdominal dressings. Note the open-mesh webbing on either side of the lace, also the adhesive straps on either side of the webbing which hold the bandage in place. The crinoline protective is partly removed from the adhesive on the left side.

patient got out of bed, obtained his clothes from the wardrobe, and watching an opportune moment clandestinely left the hospital, walking three miles before reaching home. His recovery was uneventful and complete. I hardly think he would have been able to have accomplished this feat had the ordinary abdominal binder been used. He has since passed the rigid examination for the United States Navy.

I do not claim originality for this form of bandage, nor do I recall ever having read of it, or seen others use it. If another originated the idea, I

beg to express my regrets for not having my attention called to it. For a very practical bandage see illustration VIII.

The T Bandage.—This is made as a rule from cotton flannel, and consists of two parts: a girdle of sufficient width to afford comfort, and a perineal strip three and one-half to four inches wide and one yard long, which is attached to the center of the girdle posteriorly. It is used to retain dressings after operations on the rectum, perineum, and vagina; as can be easily understood the perineal strip is passed between the thighs and pinned to the girdle in front. These bandages are generally sterilized in the same package with the dressings for vaginal and perineal operations.

Plaster-of-Paris Bandages.—Bandages impregnated with plaster-of-Paris as a means to immobilize joints, and as a substitute for wood and metal splints in the treatment of fractures is a product of American ingenuity, and was first brought to the notice of the profession by Professor Lewis Albert Sayre of New York, one of the early but noted orthopedic surgeons of the country. These bandages are made from crinoline or gauze of the desired width and length, then infiltrated with plaster-of-Paris (what is known as dental plaster is much preferred for this purpose). After being rolled, they are placed in air-tight containers, as any moisture deteriorates their value. Here again it is a waste of time and energy for hospitals to prepare this kind of bandage, as the manufacturers supply a very good grade, sealed in individual tin boxes, with full directions for use. In applying such a bandage to an extremity—

(1) Shave and thoroughly cleanse the part.

(2) Carefully incase the member in ordinary cotton wadding held in place with a gauze bandage.

(3) Immerse the plaster-of-Paris roll in a basin of water *until all bubbles cease to rise,* which indicates the water has thoroughly permeated it.

(4) Remove and gently squeeze out superfluous water.

(5) Apply to the part by making spiral or circular turns, smoothing out any irregularities with the hand. The "reverse turn" should never be made because of the extra tension this causes. A nice finish is given the cast by making a creamy paste of the plaster and rubbing the same over the surface. The number of layers necessary will vary with the size and muscular development of the part. An increased rigidity or stiffness can be obtained by reinforcements of tin or other thin metals placed between the layers of the bandage. The removal of a cast is easily accomplished by first moistening the same with hydrogen dioxid or vinegar, which softens the plaster sufficiently to permit of its being cut with a strong, sharp knife. A similar pro-

cedure is resorted to when it is necessary to cut a fenester, or window, in a cast in order to dress an injured portion of the limb, as in compound fractures or resections of bone.

Another method of making a plaster-of-Paris cast which is often used in injuries about the shoulder is—

(1) Form a pattern out of paper and lay the same on the table.

(2) Moisten the plaster roll in the same manner as above.

(3) Pass the same backward and forward over the pattern, care being taken to have each layer nicely adjusted and smooth; the number of layers will depend on the muscularity of the part.

(4) Apply and mold in place.

(5) When hardened, a few turns of gauze bandage will retain it in position. I cannot leave this subject without warning you of the dangers connected with using a plaster-of-Paris bandage in acute sprains or very recent fractures, *in fact wherever swelling is liable to ensue,* because the unyielding cast may so compress the blood-vessels as to produce gangrene, examples of which have been brought to my notice. The nurse therefore should be on the alert for any swelling that may occur after the adjustment of a plaster-of-Paris bandage.

Silicate-of-Soda Bandages.—The solution of silicate of soda as found on the market for making bandages is a varnishlike fluid, containing about 20 per cent. of silica and 10 per cent. of carbonate of soda. Bandages made from this solution are used when a lighter cast is needed than one made of plaster of Paris. It makes a clean retaining splint, is easily applied, but is not durable, and requires a longer time to harden; nevertheless for smaller joints or for light splints it answers admirably. To apply such a cast—

(1) Cleanse and shave the part.

(2) Surround the same with cotton wadding.

(3) Apply the ordinary gauze roller bandage.

(4) Varnish each successive layer with the soda solution.

(5) Repeat steps three and four until a sufficient thickness is obtained.

To remove this cast moisten with warm water and cut with a strong, sharp knife.

Adhesive Plaster.—This is a useful article in the surgeon's armamentarium. It can be obtained in rolls twelve inches wide and ten feet long, which is the most economical way to buy it for hospital use; various widths of this material may be purchased on spools. The kind known as zinc oxid is far preferable, being less irritating to the skin. Before applying

it to the surface of the body the part should be carefully shaved to permit of its adhering more firmly as well as to lessen the pain when removed. *All adhesive plaster is impermeable to fluids,* hence in applying this material to a wound or other abraided surface, *some protection should be given the injury in the way of sterile dressings beneath the plaster.* The various ways in which this material is utilized will be explained in the different technics.

Physiologic Saline or Normal Salt Solution.—This is a solution of table salt (sodium chlorid) in water, and is an evolutionary product of necessity.

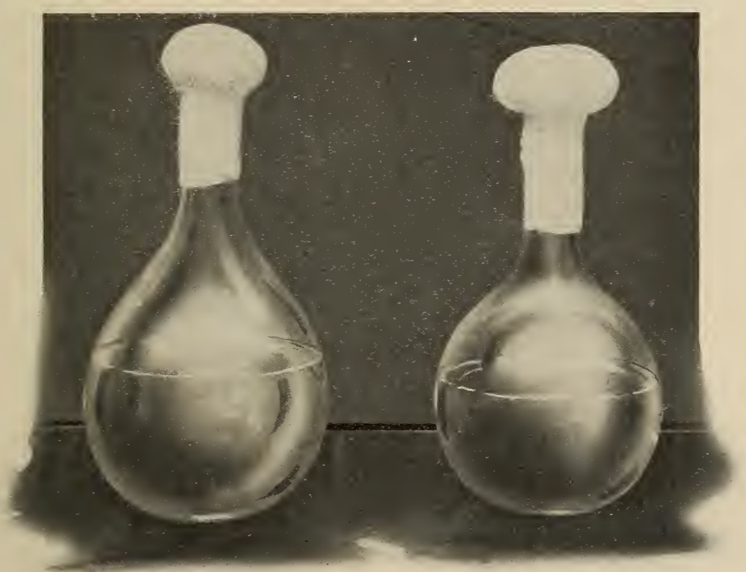

ILLUSTRATION VIIIa
Flasks of Normal Saline Solution

Experience has demonstrated that if plain sterile water is injected into the blood-current disintegrative changes occur in the corpuscles and fatal results ensue; or if thrown into the rectum the epithelium becomes swollen and absorption is exceedingly limited, hence the necessity of obtaining a fluid that could be substituted for plain water which would be bland, isotonic, and which would not have the deleterious effects I have mentioned. After numerous experiments chlorid of sodium in the proportion of 0.6 per cent. or 0.7 per cent. with water was demonstrated to fill the requirements of such a fluid, although more complicated solutions have been recommended;

occasionally oxygen gas is forced through the normal saline solution in order to saturate it before it is employed in intravenous infusions. Distilled water is preferable to ordinary drinking water for making this solution.

Directions for Preparing 1 quart of 0.6-per cent. solution. (Approximate.)

(1) In a clean flask place Chlorid of Sodium....................grs. 90
Distilled Water..................... qt. 1

(2) Stopper the flask with absorbent cotton and boil for ten minutes.

(3) Filter through cotton and again boil for a similar period.

(4) Preserve in the flask in which the solution was last boiled.

(5) Tightly stopper the flask with sterile cotton, over which is adjusted two or three thicknesses of sterile gauze held in place by a small bandage.

This solution will not keep indefinitely. Several flasks of the prepared solution should be constantly on hand in the sterilizing room.

Field of Usefulness.—After severe hemorrhage, following the effects of shock, as an irrigating fluid in *non-infected* wounds, and as a medium for nutritive enamata normal salt solution becomes one of the most useful adjuvants in surgery. (The methods of its employment are given in lecture devoted to "Transfusion—Infusion.") Having some characteristics of the blood serum it should *not* be used as an irrigating fluid in *infected* wounds or cavities, unless followed by sterile water, because it forms a fertile medium for the propagation of bacteria. I think this is a settled question.

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LECTURE VI

WARD SERVICE—HISTORY-RECORD OF THE PATIENT

The thorough equipment of the operating-room and the careful technic which has been maintained can go for naught unless each floor of the hospital is proportionately furnished with necessary requirements to carry out the scheme of asepsis. *Every floor should have a large room* equipped with the following:

(1) *A water sterilizer,* for hot and cold sterile water, connected with a porcelain sink. (See illustration IX.)

(2) *A sterilizer* for basins, pitchers, etc., heated by either gas or steam, or an *immersion trough* for the same purpose. I do not think much of this latter, because one never knows the length of time the basins have been immersed; however, it is more economical. (See illustration X and XI.)

(3) *An instrument sterilizer,* heated by steam from the boiler-room or gas. (See illustration XII.)

(4) *An aseptic stand* with four metal shelves, on which are kept the more common drugs used in surgery; the different stock solutions, basins, pitchers, graduates, glass receptacles for catheters, irrigators and the usual glass or rubber nozzles which are used with these, hand brushes, etc.

(5) *An aseptic table* with metal top. This is a very necessary piece of furniture. Besides the ordinary advantages of such a table, it serves as a stand for the gas stove or "hot plate" as it is termed, which is used in warming solutions and sterilizing the small instruments employed on the floor.

(6) *A cupboard similar to the one used in the sterilizing-room,* in which are stored the sterile dressings, sponges, bandages, adhesive plaster, and the instruments belonging to the floor. In a compartment of this cupboard (which is always kept locked and in charge of the head nurse of the floor) is also stored a complete infusion outfit, as follows:

Infusion Outfit.—

(a) Two flasks of sterilized saline solution.

(b) A complete suspension reservoir. (For description see lecture on "Transfusion—Infusion.")

ILLUSTRATION IX

A Water Sterilizer. One reservoir containing hot and the other cold sterile water.

(c) Instruments
- 2 infusion needles (dull and sharp pointed).
- 1 sharp scalpel.
- 1 pair of scissors.
- 3 or 4 small hemostats.
- 1 pair of dissecting forceps.
- 2 curved needles.

(d) Other Articles
- Number 1 catgut in original tube.
- Cocain tablets, hypodermic syringe, 1 small graduate for local anesthesia if necessary.
- 1 bottle solution adrenalin chlorid.
- 1 ward dressing outfit.
- 1 two-inch roller bandage.
- Gloves.
- 1 bath thermometer.

The instruments and such articles as can be are *sterilized with the utmost care* and preserved (with the exception of course of the flasks) in double wrappers. One of the most annoying circumstances is to have a patient suffering from shock or hemorrhage, needing an infusion and having to wait

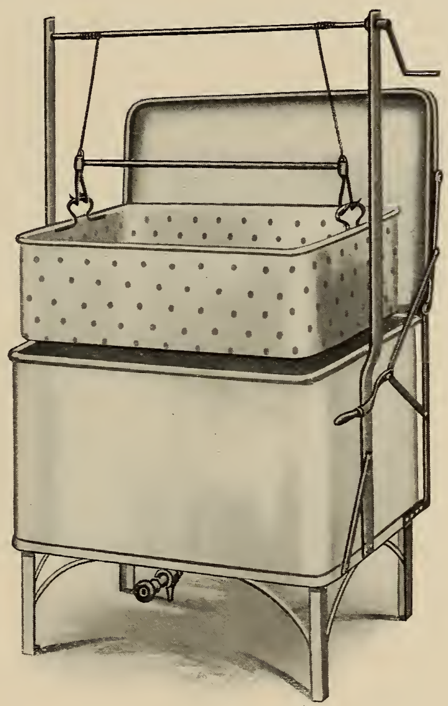

Illustration X

A Steam Sterilizer for Basins and Pitchers

an indefinite period until the various articles *are collected from the different floors.*

Clinical Charts and Sickroom Memoranda.—On every floor of a hospital there should be provided a desk, conveniently located, at which the head nurse presides. Besides the ordinary drawers in which are kept clinical charts, history forms, reception slips, requisition blanks, etc., there should be

provided a system of oblong pigeon-holes numbered to correspond with the rooms or beds on the floor, in which are kept the clinical chart, sickroom memoranda, and the reports from the clinical and pathological laboratories, *all attached to a "chart holder or file."* (See section "Blank Forms" in this lecture.) *This is the place of election for charts that are in service and not hung at the head of the bed;* in this latter location they are scrutinized by visitors and the patients themselves. A slight rise in temperature, as recorded, is at once noted by the patient; if it happens to be a neurasthenic

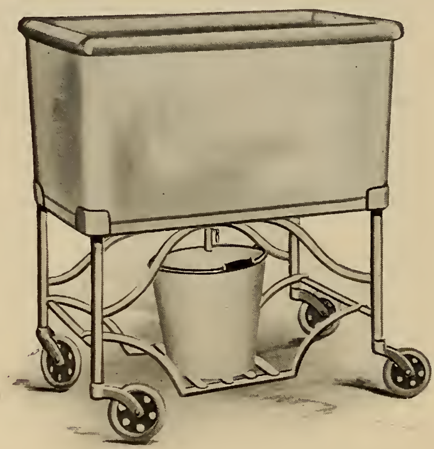

ILLUSTRATION XI

An Immersion Trough which is filled with a solution of 1 : 1000 bichlorid of mercury in which basins, pitchers, etc., are immersed in order to sterilize them.

woman, she immediately becomes worse; or if a patient who has a supposed grievance against the institution or surgeon, daily memoranda are clandestinely made in the hopes that they will aid in a lawsuit later.

The keeping of a clinical chart and sickroom memoranda is an art which should be developed, the nurse should practice "printing" by hand in preference to writing the different notations. There are varieties of clinical charts and sickroom memoranda on the market, and every hospital

has its own with some variations; yet it is not the kind of chart that is used, but the kind of information recorded that interests the surgeon. For instance, what practical deductions can be made when looking under the column for "urine" is seen "1"? *This means nothing;* no valuable information has been gained. What the surgeon needs to know is the *amount* of *each urination,* preferably expressed in cubic centimeters. If any abnormalities are present they should be mentioned under "Remarks"; the same is true of the *excreta from the bowel,* the estimated amount, color, consistency, and other peculiarities carefully recorded;—this is *particularly necessary in accident cases.*

The patient's *temperature, pulse, and respiration* should be taken and noted *as soon after admittance as possible,* not only as a matter of form, but because later reference to the *condition at that time* may be important. It is a rule to record these valuable signs four times daily, viz., at eight, twelve, four, and eight o'clock, and *more frequently if the necessities of the case demand it.* Immediately after a major operation the pulse should be counted every half hour and charted, together with any change in its character. The temperature should also receive frequent attention at this time and notations made. (See lecture on "Principles and Practice of Postoperative Nursing.")

If the case be an emergency, the most painstaking memoranda should be made; the pulse counted, its character set forth; the temperature taken, if subnormal *emphasized* to call attention to the same; the respiration recorded, whether shallow, deep, or stertorous; the condition of the pupils, whether responding to light, their size, or disparity if any is present; the color of the face; the condition of the extremities; note whether hemorrhage is present and record the same; as well as wounds if any are in evidence. The object being to give a perfect picture of the case immediately on admission. Later if a criminal or civil lawsuit is the outcome of the injury, it is accepted as prima facie evidence, and gives a "square deal" to both parties. The details of the operation, if one is made, are recorded in the history of the case.

If the patient is one for operation the surgeon in charge generally notifies the surgical intern of any special examinations he desires, such as blood, stomach contents, stools, etc., together with his orders for preparation and the day and hour the operation is scheduled. The house-surgeon writes such orders and signs his name.

The examination of the urine is considered a necessity before and after an operation, and no orders are needed to that effect. (See lectures on

the "Preparation of Patient for Operation" and "Principles and Practice of Postoperative Nursing.")

The daily memoranda should also set forth the condition of the patient's *appetite and the amount of nourishment* taken. I look on this as one of the true indices of a patient's convalescence. Cases giving every indication of recuperation, such as the return of the pulse, temperature, and respiration to normal, whose excreta give no evidence of abnormalities, but whose appetite has not returned and to whom food is repugnant, must be looked on with suspicion; something unforeseen is developing, hence this important item should be carefully recorded.

The chart should indicate *what drugs* have been given and the time of administration. This is especially true of morphin and other anodynes; as two important indications are gathered from this information, either the patient is in pain or has developed a habitus, which is not uncommon in chronic cases.

The amount of *stimulation,* if any is given, must be charted; this includes rectal seepage, infusion of salines, etc.

The number of hours the *patient slept* is worthy of notation.

After a wound has been dressed the nurse should record the condition of such wound, the kind of dressings used, the surgeon, assistant, or nurse who made the dressing, note the character of the discharge if any, and whether the same is increasing or decreasing.

The *hour of the day* a patient is taken to the operating-room should be recorded, as well as the time of return.

After an operation where *drainage* has been used, or *vaginal* or *uterine packing employed,* the surgical intern or assistant *should make a notation to that effect on the patient's chart and sign his name,* because if the vagina or uterus has been packed the patient should be catheterized; it also serves to remind the surgeon and nurse of the same so that it may be removed at the proper time, and not permit the patient to discover it herself weeks after. The same is true of drainage,—it is occasionally forgotten (unless charted) until a chill with an increased temperature directs attention to the wound, when the cause is discovered. After these "necessary evils" are removed they should be recorded, together with the name of the surgeon or nurse who did it. *The nurse is not responsible for accidents similar to the above, if a notation is not made on the chart after the operation.*

It is the nurse's prerogative, one of the few she possesses, to demand that the *surgeon write his daily orders in full for each patient,* either on

the daily memorandum-sheet, or in an order-book which is kept for that purpose. At the close of each day a short synopsis is recorded as follows:

(a) The highest temperature, pulse, and respiration.
(b) The lowest temperature, pulse, and respiration.
(c) The amount of urine excreted.
(d) Number of defecations.
(e) The amount of anodyne administered, if any.
(f) Condition of appetite.

Extraordinary symptoms, or conditions that require emphasis, should be printed in red ink in the column reserved for "Remarks." The *clinical chart* should be compiled from the daily memoranda. It is not considered the nurse's duty *to take the history of the patient.* If the case is a *private one,* the surgeon's assistant performs this task, and if a *charity one* it is the duty of the surgical intern to compile it.

Blank Forms.—Sickroom-memoranda forms, clinical charts, anesthetic slips, and clinical and pathological-report blanks have become practically standardized and may be purchased of any well-equipped surgical supply-house.

History-record of the Patient—*Compiling the History of the Patient.*—In all well-equipped hospitals a history is kept of each patient. Some of these history-forms are very extensive, giving the minutest details; others are simplified, touching only the salient points of the individual case, yet sufficiently explicit to permit correct deductions to be made from an analysis of a given number of records—which really is the end in view. They also serve as a protection for the conscientious surgeon from those vicious productions of the "ambulance chaser,"—the malpractice suit. Nothing reflects any more discreditably on a hospital than to see poorly kept history-records. I think without any exaggeration I may say that a correct conclusion can be made as to how a hospital is managed by glancing through the manner and method in which the history-records are kept. If care is taken in the compiling of these important articles, rest assured the institution is under the supervision of one who is striving to maintain its efficiency in all of the various departments.

All surgeons and hospitals have their own ideas as to the necessary data which should be recorded, the nurse therefore would hardly ever be required to formulate a history-form; an occasion may arise however when she may be called on to suggest a suitable blank-form for history-records in which case the following will assist as a working basis. It is applicable to both general-surgical and gynecological cases:

HISTORY OF PATIENT.

Date ______________________

Service of Dr. ______________________ *Referred by Dr.* ______________________

Diagnosis ____

Case No. __________ *Name* ______________ *Address* ______________

Age ____ *Sex* ______ *Social Relation* ______ *Occupation* ______ *Race* ______

Complains of the following ______________________________________

____

Family History ____

____

Previous History ____

____

Present History in order of development ______________________________

____

Physical examination—(Abnormalities only are recorded) ______________

____

Date and character of operation ______________________________

____

Details of operation ____

____

Postoperative Complications and Treatment ______________________

____

Result ____

Discharged from the Hospital ______________________________________

Subsequent History ____

History compiled by Dr. ____

N. B. This history is not to be filed until the clinical chart, anesthetic slip, and the clinical and pathological reports are attached.

Compiling the History-record.—The compilation of a patient's history is an art which some never acquire, while others seem to be able to grasp the important items in any case, group them in sequence, and express the facts tersely in a few words. While brevity should be the aim, it should not be carried to such an extent as to curtail the important points and omit the essence of the history. Two questions have always arisen in hospital

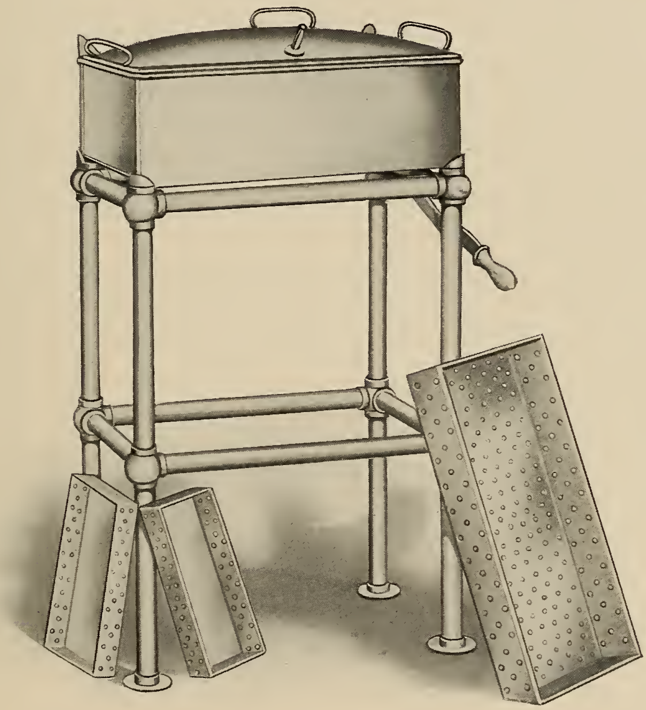

Illustration XII
A Steam Sterilizer for Instruments

practice regarding the compilation of the patient's history: (1) Is it proper and ethical to place on record the confidential and important statements made by the patient to the surgeon? (2) Who shall compile such histories, the surgical intern, or the surgeon's private assistant? The latter question can be easily settled by the surgeon. The private assistant is better qualified for this purpose. As to the propriety of placing a private

patient's history on record in a public hospital there may be some room for argument, but certainly there should be no serious controversy, because during the operation the surgical intern and the nurses witness the character of the operation and but for their ethical obligation could easily reveal the nature of the case. The same is true of the pathologist: the examination of the specimens submitted to him at once indicate the character of the disease with which the patient is afflicted, but his sense of moral duty is sufficient restriction to prevent a breach of trust. The typist, stenographer, or secretary who keeps the records after they are filed is as much bound by ethical obligations to preserve secrecy as the stenographer in the surgeon's office who writes his private letters. In fact in Ohio and some other states it is a criminal offense for a stenographer or secretary to reveal information obtained in his or her line of duty. The records should be kept with the same secrecy as the private letters and other business transactions of the hospital. Carefully compiled history-records are as large an asset as an institution can possess.

Filing the History-records.—At the present time filing-cabinets consisting of a section for each letter of the alphabet can be purchased for this purpose; these sections may be subdivided into the five vowels to facilitate finding the individual record. To illustrate: suppose the patient's name is Jones, the record should be filed in the section "J," subdivision "O," because "J" is the first letter in the surname and "O" the first vowel occurring in the name. This cabinet index must be used in connection with a counter index, which may be either an ordinary book index, or a card-system. The card or page of the book should contain the following data:

CLASS OF OPERATION	DATE	NAME OF PATIENT	SURGEON	RESULT

To illustrate the use of this counter index, suppose the surgeon desires to ascertain the number of appendectomies he has made during a given period and the results following a certain line of treatment. The clerk of the hospital can immediately refer to the counter index under the letter

"A" and give the number of such operations, the names of the patients, the dates of the operations, and the results. Should the surgeon require minute information on one or all of the cases the clerk refers back to the chief index and obtains the history-record of each patient. To be concise the chief index classifies the history-record *under the name of the patient* and the counter index classifies the *character of the operation.* One cannot be successfully used without the other.

LECTURE VII

PREPARATION AND STERILIZATION OF SURGEON'S AND NURSES' HANDS

It must be borne in mind that there are certain locations in the skin where bacteria normally exist, viz., under the epidermis, in the shafts of the hair-follicles, and the ducts of the sudoriferous (sweat) and sebaceous (oil) glands.

You can therefore easily understand that efforts at skin sterilization must be so applied as to remove all dead epidermis from the surface; in addition such measures must be used as will have a tendency to dilate the mouths of the sweat and oil glands and increase their excretions, in the hope that such bacteria as are present may be eliminated. This latter thought can hardly be considered theoretical, inasmuch as actual experience demonstrates that while the excretions from these glands may show bacterial growths after surgical cleansing of the hands and immediately before an operation, these cultures get less and less as the glands pour out their excretions during operative procedures because the increased perspiration and oily excretion dilute the bacteria more and more, until eventually they are minimized. *Perfect skin sterilization is not known.* Efforts along this line have their limitations,—all that can be accomplished is to reduce the number of bacteria, and to hold in check their virulence.

Before hand sterilization is begun it is necessary for the surgeon to change his street clothes and assume his *operating-suit,* shoes, and head-gear (cap or turban). The nurse likewise changes her uniform and substitutes an *operating-gown,* and covers her hair according to the hospital method.

After the hands have been sterilized according to the methods to be described, the surgeon assumes his gown and adjusts sleevelets and gloves, while the nurse covers her gown with the nurses' *bib-apron,* and adjusts gloves and sleevelets. (See illustration XIII.)

Basic Principles—Mechanical Cleansing.—(1) Trim the finger-nails reasonably close.

(2) Immerse the hands for a minute or two in warm water. This softens the dead epidermis under which bacteria are prevalent, and assists in dilat-

ing the mouths of the sweat and oil glands as well as increasing their excretions, thus forcing to the surface the underlying and hidden bacteria.

(3) With a fairly stiff brush, soap, and water, methodically scrub every portion of the hands and arms for five minutes, paying special attention to the nails, inner side and back of the forearms. Cleanse the under surface of the nails with a sharp orange stick or nail file, the former being preferable.

(4) Again revert to the scrubbing process for another period of five minutes. During this procedure the hands, arms, and brush have frequently been rinsed *under the running water,* and the soap as repeatedly applied, so that the same dirty mixture is not continuously used over the surface.

(5) Rinse with sterile water and use whatever antiseptics meet the approval of the surgeon.

It is a frequent occurrence to see the most expensive "medicated" soaps purchased by institutions for use in this connection, and at the same time see brushes employed that have long passed their stage of usefulness. I do not think any special kind of soap has any specific value; preference, however, may be given to *sterilized green soap,* because of the large amount of caustic potash which it contains, but when this cannot be obtained, as in private practice, the ordinary domestic laundry soap is equally efficacious. I do not use a basin in hand sterilization in the hospital, *relying on running sterile water;* in private practice this will not be possible.

ILLUSTRATION XIII

A surgical nurse in complete uniform. Note the manner in which hair is covered. Observe the bib-apron which has been assumed after the hands have been cleaned.

This *mechanical cleansing of the hands and forearms* is common to *all methods, and is more important than all the chemical antiseptics* which may be used. If a step is omitted in hand sterilization allow it to be any *except the mechanical scrubbing with soap and brush with frequent changes of copious volumes of warm sterile water.* Germicides and antiseptic solutions quiet and calm the conscience of the surgeon and nurse, but mechan-

ical and methodical scrubbing as I have described is *the important step* in our present knowledge of removing infectious material from the hands, as well as the field of operation. From this point variations occur—

Method One.—

(1) Mechanically cleanse.

(2) Take equal portions of chlorid of lime and carbonate of soda; add enough water to make a paste, apply freely to the hands and arms. This mixture eliminates chlorin gas, which imparts a warmth to the skin. When this has subsided,

(3) Remove the same with sterile water.

(4) Immerse the hands and arms in a solution of corrosive sublimate (1:2000).

(5) Rinse the members with alcohol.

(6) Dry with sterile towel.

This method was first suggested by Weir of New York and has the support of a large number of surgeons. Its chief disadvantage is, that if used frequently it produces an acute eczema.

Method Two.—

(1) Mechanical cleansing.

(2) Hands and arms *thoroughly dried and rubbed* with a sterile towel.

(3) Then scrubbed with gauze saturated in alcohol (94 per cent.).

(4) Again dried with sterile towel.

Method Three.—

This is the method I have employed for some years, with results as perfect as any I know.

(1) Mechanical sterilization.

(2) Immerse hands and arms in a basin of Harrington's solution for one-half minute.

(3) Neutralize with alcohol.

(4) Dry and rub with sterile towel.

This method will also irritate some hands, but no more than other methods; my confidence in Harrington's solution gives it preference to other antiseptics.

LECTURE VIII

PREPARATION OF PATIENT FOR OPERATION

Formerly all patients who were to undergo a major operation were subjected to days, and in many cases weeks, of preparatory treatment, which consisted chiefly of drastic purgatives and so-called tonics. In those days the profession did not individualize as carefully as at present; the strong and robust, the weak and debilitated, the nervous and lymphatic patient, all received the same routine. The surgeon overlooked the fact that the neurasthenic patient was being rendered more incapable of undergoing the ordeal from the psychic effects of anticipation and the hospital environments, while the strong and robust deprived of their usual liberty were being reduced unnecessarily. It is true nothing was known of what is now termed "resisting power;" blood examinations had not yet been brought to the attention of the profession; antisepsis was in its infancy, *and everything gave place to it.*

For the sake of description I think I can divide operative cases into three classes—

(1) Those with acute fulminating infections, those with ruptured ectopic pregnancies, and subjects for Cesarean sections,—to be exact, *emergency cases,* where systematic preparatory treatment is out of the question.

(2) Those acute or subacute cases in which the *general health* has *not been depreciated* and *time is not a factor,* as in the former class; such cases do not require over twenty-four or forty-eight hours' preparatory treatment at the most.

(3) The patients that belong to this division are those whose health has been undermined by chronic diseases and long standing infections. The majority of this class are poor hard-working people who depend on their own efforts for a livelihood; these require rest and hygienic attention to bring their powers of resistance to as high a point as possible before operative measures are instituted.

With the exception of the first or emergency class, in which *time is the important element,* there are certain principles that must be followed out.

As a rule the following preparations begin twenty-four hours previous to the time appointed for operating. The patient should be put to bed

and given a thorough sponge bath, after the bedding has been protected by rubber sheeting. This is done not only for cleanliness, but *also to remove such debris* as has accumulated on the skin, and which prevents that organ from functionating to its fullest capacity, for as you will recall in your lectures on physiology, the skin acts as a supplementary organ to the kidneys in the elimination of toxic materials from the body; therefore in giving the bath be as thorough as the condition of the patient will permit.

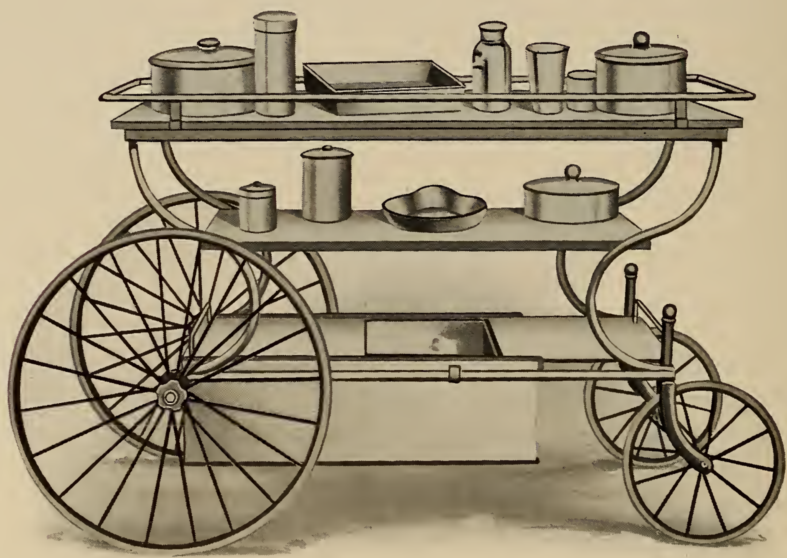

ILLUSTRATION XIV

An ordinary Dressing Car.—Note the waste receptacle for soiled dressings, etc.

You will note that I have specifically mentioned a *general sponge bath,* because the *bathtubs* in the *average* hospital *are filthy, laden with pathogenic germs, and actually infect the surfaces we are striving to cleanse. The basins employed must be sterilized by boiling, as these innocent-looking receptacles are commonly used in the cleansing of purulent wounds, and hence may become a source of infection.* A clean nightgown is then put on the patient; if a woman, her hair is braided and securely tied, and finally the nails are manicured. Nothing jars the sensibilities quite as much

as to see dirty finger-nails; especially is this true of the surgeon, nurse, or patient. These steps may be termed the "esthetic toilet," but in reality they are more than that. The patient may now be allowed to rest for some hours before beginning the *surgical toilet.* Only such a nurse as has had lectures on surgical nursing, bacteriology, asepsis, etc., should be selected to prepare the field of operation, because she appreciates the dangers of infection and the difficult task of skin preparation. In my opinion a rule should be established in every hospital that this task be assigned the *senior nurse of the floor.* In some hospitals one of the operating-room nurses is assigned the task of the preliminary preparation of the field of operation. This is quite appropriate, inasmuch as such a nurse realizes the necessity of thorough work and scrupulous care.

Preliminary Duties.—A ward *dressing car* should be equipped with such articles as will be necessary in the preparation of the patient. These, of course, will vary according to rules established by individual surgeons for this purpose. The same basic principles of asepsis, however, must obtain. (See illustration XIV.)

Equipment of Ward Dressing Car.—

(1) 2 sterile basins.
(2) 2 large flasks or pitchers, filled with warm sterile water.
(3) 1 soft sterile brush and green soap.
(4) Such antiseptics as are used by the individual surgeon.
(5) 1 package of sterile towels.
(6) 1 package of wipe sponges.
(7) 1 package of cotton-gauze dressings and abdominal binder, if the field of operation is the trunk, or suitable dressings and bandages for other portions of the body.
(8) 1 safety razor or depilatory powder.
(9) 1 Kelly pad, 1 rubber sheet, both carefully cleansed. (See illustration XV.)
(10) 1 bowl boracic-acid solution (4 per cent.) for cleansing the meatus urethrae prior to catheterization.
(11) 1 sterile glass female catheter.
(12) 1 sterile bottle for specimen of urine.
(13) 1 sterile bib-apron for nurse, after mechanical cleansing of the patient has been accomplished.
(14) Such other articles as may suggest themselves for the individual case.

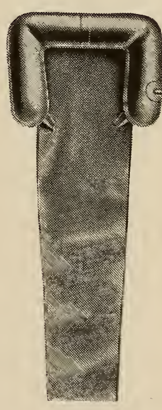

ILLUSTRATION XV

A Kelly Pad—A useful article, but one difficult to keep sterile.

Nurse's Preparation.—This has been deferred until after the preparation of the ward car because of the danger of contaminating the clothing while preparing the outfit. Carry out the following schedule:

(1) Roll the sleeves of the hospital uniform well above the elbow.

(2) Cover the hair with cap or turban. This is obligatory.

(3) Assume sterile gown.

(4) Mechanically sterilize hands and arms for the usual ten minutes. (See lecture on the "Preparation and Sterilization of Surgeon's and Nurses' Hands.")

(5) Complete sterilization of hands with such chemical antiseptics as meet the individual surgeon's views.

(6) Adjust two pairs sterile rubber gloves.

The car is now removed to the patient's bedroom and the following steps carried out, which are known as

The Primary Preparation of the Field of Operation.—(1) Remove the *outer wrapper* from the dressings, towels, etc., so as to *prevent contamination* of the hands *later on.*

(2) Protect bedclothing by use of rubber sheet.

(3) Inflate Kelly pad and place the same at the edge of the bed, provision being made for proper drainage.

(4) Move patient to the edge of the bed in such a position that the field to be cleansed will correspond with the pad.

(5) Arrange nightgown so that it does not interfere with manipulations by protecting the garment with towels.

(6) Shave thoroughly the field of operation; using as you will the modern safety razor, there will be no danger of the unsightly scars that are commonly seen. Some surgeons prefer a depilatory paste which is made as follows, according to the formula and instructions of Dr. N. C. Morse of Iowa:

Crystallized sodium sulfid......................	ʒ 3
Unslaked lime (fresh).........................	ʒ 10
Pulverized starch..............................	ʒ 11

These ingredients are reduced to a powder separately, then mixed and kept in a hermetically closed bottle. A sufficient amount of this is mixed with water into a paste, applied generously for four or five minutes; the parts are then washed.

(7) Begin mechanical sterilization with soap, water, and brush, using mild friction; rinse repeatedly during the usual period of ten minutes, not

only to cleanse the surface of the skin of its loose epidermis, but that the friction and warm solutions may excite the excretions of the sweat and oil glands of the skin and thus bring to the surface such bacteria as are hidden in the recesses of the sudoriferous and sebaceous glands. Especial care will be taken to extend such manipulations over a *larger surface* than is necessary and paying attention to the different *flexures* of the body, the *umbilicus,* and the *folds* of *fat* in the *obese.*

(8) Wash the field *thoroughly and copiously with sterile water, dilution is the desideratum.* From this point on asepsis must govern each step.

(9) Remove outside pair of gloves and assume bib-apron.

(10) Adjust towels around the field of operation so as to protect everything that is not sterile.

(11) Use such antiseptics as meet the views of the individual surgeon and follow by copious rinsing with sterile water so as to remove all irritating antiseptics, *finally dry the field.* I prefer Harrington's solution (subsequently neutralized with alcohol) for the following reasons:

- (a) The formula contains alcohol, which aids in the removal of the saponified fats and oils of the skin and thus cleanses the mouths of the oil and sweat glands more thoroughly.
- (b) Experience has demonstrated this solution to be more efficient than any other.
- (c) The odor is pleasant as compared with the different mixtures of iodin and benzin or ether which some surgeons employ.

(12) Apply cotton-gauze dressings held in place by a well-fitting abdominal binder and instruct the patient under no circumstances to disturb or infect the field by contamination with the hands.

I desire to give you the philosophy for the use of ether, benzin (gasolin), or alcohol, *after the mechanical sterilization* has been accomplished. All three of these drugs are excellent solvents for fats, hence they are employed to remove such oily matter as remains on the surface of the skin and in the mouths of the sudoriferous and sebaceous glands. Benzin is being used by some surgeons medicated with iodin in the proportion of 1 per cent. for the *preliminary cleansing* of the field of operation, while a stronger solution (5 per cent.) is utilized on this area just before operating. This product of petroleum has no advantage over ether or alcohol except from the standpoint of economy, which is more than offset by its objectionable and lasting odor.

Whatever antiseptics are employed you will note that the toilet of the patient when complete is *perfectly dry,* which is preferable from the standpoint of comfort, besides being more scientific than the moist dressings of

former days. Keen's Surgery remarks on this topic: "He (the patient) is allowed to pass the night without the discomfort of a wet antiseptic dressing. These dressings are not only a source of discomfort and annoyance, but they irritate the skin, *contributing,* if anything, against a sterile field."

The Soap Poultice which was formerly used is made of equal parts of green soap and glycerin, in which is immersed a gauze towel that is applied to the field of operation after it has been prepared, and allowed to remain in place for twelve or fifteen hours. It is *only mentioned to be condemned,* because it macerates the tissues, develops greater fertility of the skin, and frequently produces dermatitis.

Obtaining a Specimen of Urine.—After the field of operation has received the primary preparation, it will be the nurse's duty to obtain a specimen of urine. In female patients a catheter should be used. This is the appropriate time for catheterization because the nurse is properly gowned, her hands sterilized and gloved, and the necessary articles are at hand to perform the same (being part of the equipment of the ward car).

(1) Sterilize the urethra and adjacent tissues with the warm saturated boracic-acid solution.

(2) Protect the surrounding area with sterile towels.

(3) Lubricate the catheter and introduce into the bladder, preserving the urine in the sterile bottle which has been prepared for the same.

Catheterization is necessary in women patients, otherwise the specimen of urine intended for analysis becomes mixed with the vaginal excretions and does not give a true conception of its contents. The bottle is labeled with the name of the patient, number of room or ward, and date, and sent to the clinical laboratory, the analysis of which is attached to the patient's clinical chart, together with such other reports of examinations as have been ordered, as blood-counting, analysis of stomach contents, etc.

The examination of the urine is one of the essentials in the preparation of the patient for operation.

Modifications in the Preparation of Special Locations—*Head.*—In major operations on the cranium *the entire scalp should be shaved.* The average specialist does not require this in operations on the mastoid, simply demanding a generous field, unless there is suspicion of thrombosis of the lateral sinus, in which case the general rule prevails,—shave the entire scalp. When complete depilation is ordered it facilitates the sterilization, but in cases where only a local area is to be shaved, the remainder of the hair and underlying scalp have to be made as aseptic as possible,—a most difficult

task. In the former case, the general rules as to the preparation of the field are carried out, *and in addition, the scalp painted with tincture of iodin previous to applying the protective dressing.* While in the latter, after the local area has been shaved, the hair is shampooed thoroughly, repeatedly rinsed with sterile water, then with alcohol or ether to remove all soap and oleaginous material, and finally with mercuric solution 1:2000, and dried; the local area is then painted with iodin and the protective dressings applied. Or Harrington's solution may be employed after the rinsing with sterile water, in which case it is neutralized with alcohol, dried, the field of operation painted with tincture of iodin, and the usual protective dressings made.

Mouth.—Here the high degree of immunity that exists precludes the necessity for any elaborate preparation. Like other muco-cutaneous cavities it is impossible to carry out the usual methods of surgical cleansing, nevertheless it is your duty to endeavor to produce as aseptic a condition as possible by having the patient use an alkaline antiseptic mouth wash with a tooth brush every three or four hours the day before the anticipated operation, and once or twice the morning of the same day. This procedure seems imperative, not only in surgery of the mouth, but *also in operations on the stomach* as shown by recent investigations. Furthermore it should be a rule that *mouth cleansing be considered* one of *the essential steps* in the preparation of the patient who is to be given a *general anesthetic,* as undoubtedly pneumonia has been caused by neglect of this. (See lecture "Anesthesia—Anesthetics," section "Preparation of the Patient.")

Stomach.—This organ in a healthy individual is amicrobic (free from bacteria). In cases of pyloric obstruction the result of gastric ulcer or cancer the stomach is unable to completely empty itself of its contents and the residual food goes through a process of putrefaction with its accompanying bacterial growths. It is chiefly for these conditions, in which a complete evacuation of the stomach does not occur, that surgical procedures are instituted. Hence when preparing a patient for an operation on this organ liquid nourishment should be administered to facilitate the stomach emptying itself, followed in three or four hours by lavage to remove any residue of food. Nourishment must never be administered later than six hours before operation. Thorough lavaging, sterile dietary, and cleansing of the mouth, as has already been mentioned, will produce a sufficiently aseptic condition for surgical purposes. An analysis of the stomach contents and an examination of the feces is frequently desired by the

surgeon in these cases—the report of which should be attached to the patient's clinical chart, thus adding important items to the history-record.

Face.—The general rules as to preparation prevail. Attention must be paid to the hair, scalp, and mouth as these are the chief sources of infection following operations in this region.

Thorax.—No especial rules are necessary in the preparation of this field, but great care however must be given the axilla, with its superabundance of sweat and oil glands and hair follicles,—a fertile field for bacteria. The flexure of the breast on the chest wall should receive close attention, and if any eczema be observed the same should be brought to the *surgeon's notice at once,* as he may desire to postpone the operation until the same is healed, or use some extra precaution locally for a day or two, previous to surgical interference. *Fatal infections from an insignificant dermatitis in the field of operation are on record.*

Rectum.—The majority of surgeons make no attempt at sterilizing this organ previous to operation. In fact it would appear superfluous and yet those who make this field a specialty assert that better results are obtained when attention is paid to the toilet of the rectum than when no attempt is made along these lines. The day previous to operation injections of a solution of hydrogen dioxid (25 per cent.) are administered morning and night, which simply *act as solvents* for any concretions that have accumulated in the pockets and rugae with which this organ abounds. These solutions are expelled. Enemata of warm boracic-acid solution (2 per cent.) are then given, and allowed to be retained as long as possible.

The Vagina.—Inasmuch as this organ is frequently the site for surgical operations, and the results so dependent on its thorough sterilization, I deem it necessary to lay stress on the following steps looking toward the primary cleansing of this canal:

(1) Place the patient athwart the bed on a Kelly pad with the usual provision made for drainage of the cleansing solutions.

(2) Shave the parts or use depilatory powder, and cleanse the surrounding cutaneous surfaces.

(3) With a small, soft sterile brush, soap, and water carefully scrub the vaginal canal, frequently lavage with sterile water.

(4) Irrigate with *carbolic acid* (2 per cent.) or *lysol* (2 per cent.)

(5) Apply a cotton-gauze dressing held in place by a "T" bandage.

(6) After evacuations of the bowel or bladder, cleanse the cutaneous surfaces with one of the above antiseptic solutions. Dry and reapply bandage.

Bladder.—This organ should receive careful attention prior to operative procedures by being thoroughly lavaged two or three times the day previous

to operation, either with solutions of permanganate of potash, argyrol, or boracic acid and an irrigation of one of these drugs just before the time set for operation. A sterility of the urine is supposed to be accomplished by the administration of hexamethylenamin (urotropin), 5 grains, every three hours. In cases where the urethra is much stenosed (strictured) it may be impossible to irrigate this viscus, under which conditions the internal medication I have mentioned must be relied on.

Hands and Feet.—These deserve as careful attention as any portion of the body about to be operated on: the hands are constantly exposed to infection, while the feet are a fertile field for bacteria. Some of the most severe infections following minor operations on the hands and feet that have come under my notice have been the result of careless preparation. The usual rules as laid down must be carefully carried out, with special attention given the nails and flexures between and under the digits.

Further Necessary Preparation—*Diet.*—The menu of a patient about to be operated should be regulated for twenty-four hours previous to such an ordeal, but not restricted to a point bordering on starvation, the powers of resistance must be conserved, and not reduced. To accomplish this the diet list should consist of easily digested articles of high nutritive value, which will leave as small a residue in the bowel as possible and not cause gaseous formations. The usual *extracts of beef* as found on the market for making bouillon and the various *meat broths* as served in hospitals are absolutely worthless from the standpoint of nutrition: they contain the flavoring extracts of the meat and possibly are pleasing to some tastes. I take advantage of this latter quality and make them a vehicle for the administration of *egg albumen,* thus obtaining a bouillon or broth with a definite value. The usual manner of serving egg albumen, viz., whipping the white of egg and adding it to lemonade or broth, which makes a murky looking mixture, is not conducive to tempting an appetite. A more desirable way is to whip the whites of several eggs to a "stiff froth," as expressed in the vernacular of the cuisine, which is then put in the refrigerator for an hour or two; when needed the froth is removed and a clear liquid is left. A definite amount of this is added to the desired vehicle, probably a half ounce to a glass of orange or lemonade, or a similar amount to a cup of bouillon.

I do not use *milk* in any form as an article of diet *immediately before and after abdominal operations,* and in advising against it I think I express the views of most operators; however it is your place as nurses to obey orders, not give them, yet the best nurse is the one *who in the absence of definite instructions* can fill an emergency, and you will be on the safe side if you omit milk as an article of diet in *abdominal cases* unless otherwise advised. My reason for not using this food is, it is seldom thoroughly digested as the

common occurrence of curds in the stools of patients demonstrate; these undigested particles form a most excellent culture-medium for the colon-bacillus; hence it is one of the greatest factors in the production of flatus, which latter is the surgeon's bete noire during manipulations in the abdomen, and after surgical interference it adds great discomfort to the patient. On the other hand when the *abdominal cavity is not the field for operative attack* and the digestive system is in a normal condition, milk is an important article in the dietary of the patient; its diuretic qualities are not to be underestimated, while the many ways it can be utilized render it a factor in feeding the surgically sick. The following diet, I think, will suit the average surgeon:

MENU.

Breakfast—Orange or grapefruit; oatmeal with cream; soft-boiled eggs; bacon, toast, coffee or tea with cream.

Dinner—Bouillon prepared with egg albumen, medium cooked roast beef, toast, baked apple, coffee or tea with cream. Fruit is permissible if the patient desires it.

Supper—Bouillon (albumenized), baked fish or broiled oysters or chicken, toast, coffee or tea with cream. Oatmeal is well indicated.

If the operation be other than a celiotomy I would add milk and the various custards to the above. In this list I have not seriously interfered with the usual meals of the patient, but at the same time have omitted such articles as would contribute to digestive disturbances. On retiring for the night a cup of albumenized bouillon or albumen lemonade may be given, especially in debilitated patients.

Drinking Water.—I have advisedly left the subject of water for special consideration because of its importance. To appreciate the necessity of giving a patient about to be operated plenty of this fluid a day or two previous, one must remember that the kidneys are the great excretory organs of the economy, that the largest amount of body-waste is eliminated through them; that when these waste products are not excreted they form toxic principles which tend to break down "body-resistance,"—the very factor to be conserved. It must be borne in mind the kidneys can be stimulated to increased activity by drinking large amounts of bland fluids and they can be lavaged, so to speak, in the same manner. I think of no step in the preparation of the patient more often neglected and which is so necessary.

When one considers the fearful thirst that is a sequence to celiotomies, and the diminution of the watery elements of the blood following the inhalation of chloroform or ether; when one thinks of the loss of animal fluids which may take place, such as hemorrhage and persistent vomiting, neither of which can be foreseen; when one recalls the irritating effects of ether on

the kidneys; when one realizes the importance of gastro-intestinal rest after abdominal sections, which includes the withdrawing of all fluids for a greater or less time after the operation, I think you will agree that it is imperative to give the patient not only all the water desired, but encourage the drinking of a superabundance. It is common observation, however, in hospitals where the most elaborate preparations are made, to witness this common-sense necessity neglected. *With those surgeons who do not use proctoclysis after celiotomies, but who permit water to be administered by the mouth immediately after nausea and vomiting have ceased, the superabundance of this fluid the day previous is especially indicated. Not because the administration at that time can in any way take the place of water administered by way of the rectum after operative measures, but from the fact that it is an endeavor in a meager way of flushing the circulatory and urinary systems. Proctoclysis in postoperative cases, especially in celiotomies, will sooner or later become thoroughly appreciated by a larger class of surgeons than at present recognize its beneficent effects, both as a means of flushing the economy and permitting gastro-intestinal rest.*

The patient should drink *at least two quarts* of water the day previous to operation and as much more as possible; while food should cease six hours before the appointed time for operating, water may be continued to within three or four hours.

Cathartics.—Castor oil (oleum ricini) is the best pre-operative cathartic. A sufficiently large dose (2 ℥) which will produce one or two copious evacuations of the bowel, should be given in the interval between dinner and supper. If less is administered, the patient is irritated by numerous small evacuations, and if taken before retiring the night's rest is disturbed. The unpleasant taste may be concealed by the use of some sour wine or lemon juice. Some operators use one of the different salines, others calomel, or a laxative pill of some kind.

Hypnotics.—I am very much in favor of administering one of the newer hypnotics, such as veronal 10 grs. or trional 15 grs. to nervous patients the night previous to the operation. Eight or ten hours sleep affords rest, and obliterates the psychic effects the anticipated ordeal produces.

Enemata.—At least four hours before being taken to the operating-room the patient should receive rectal enemata of soapsuds or normal salt solution to cleanse the lower bowel. If given later than this some portion of the enema may be ejected on the operating-table.

Patient's Attire for the Operating-room.—A short time before the hour set for operation, prepare patient in following manner: A clean short muslin nightgown of the usual hospital pattern is placed on the patient, together with a pair of long canton-flannel stockings reaching to the hips, and a turban made of two-ply 20 by 24-mesh gauze is adjusted to the head.

ILLUSTRATION XVI

A Common but Improper Method of Hypodermatic Medication. Objections to this method are that it produces more pain than is necessary, and increases the liability to infection because of the numerous glands which are penetrated by the needle.

ILLUSTRATION XVIa

The Proper Method of Hypodermatic Medication. By this method fewer nerve endings are injured, and less pain is therefore produced; infection from the superficial glands is reduced to a minimum. A short fine needle should be employed. The outer surface of one of the upper extremities is usually chosen as the site for injection. The needle must be sterilized by boiling, and the location for injection cleansed with alcohol before the drug is administered.

Alkaloidal-narcotic Medication.—From half an hour to two hours before the anesthetic is to be administered it is the custom among a majority of surgeons to order a hypodermatic injection of morhpin and atropin, or morphin and hyoscin (scopolamin). The reasons for the use of these drugs are:

(1) It acts as a sedative to the nervous system and produces a quiescent state of the brain—very important points.

(2) It prevents the accumulation of mucus in the throat and bronchi.

(3) It "cuts out" the vagus nerve and thus prevents sudden collapse in the early part of the anesthetic (ether or chloroform), or in operations on the neck occurring in close proximity to this nerve the mechanical irritation caused by the operative procedure may also develop similar results.

(4) Less anesthetic is required (see lecture on "Anesthesia—Anesthetics," section "Mixed Anesthesia").

Catheterization.—This is the last step in the preparation of the patient. It is surprising how quickly urine collects in the bladders of nervous women, and frequently if allowed to urinate they will not entirely empty the viscus; hence, the patient should be catheterized *immediately before being sent to the anesthetizing-room;* following out the same precautions of sterilization as have been given you.

The transfer of the patient to the anesthetizing-room is accomplished on a wheel stretcher, equipped with a blanket folded to fit and a small pillow, the patient being covered with a blanket and clean sheet.

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LECTURE IX

POSITIONS OR POSTURES OF THE PATIENT UTILIZED IN SURGERY

It frequently becomes necessary when making examinations of the patient, or when performing operations, to place the subject in certain postures

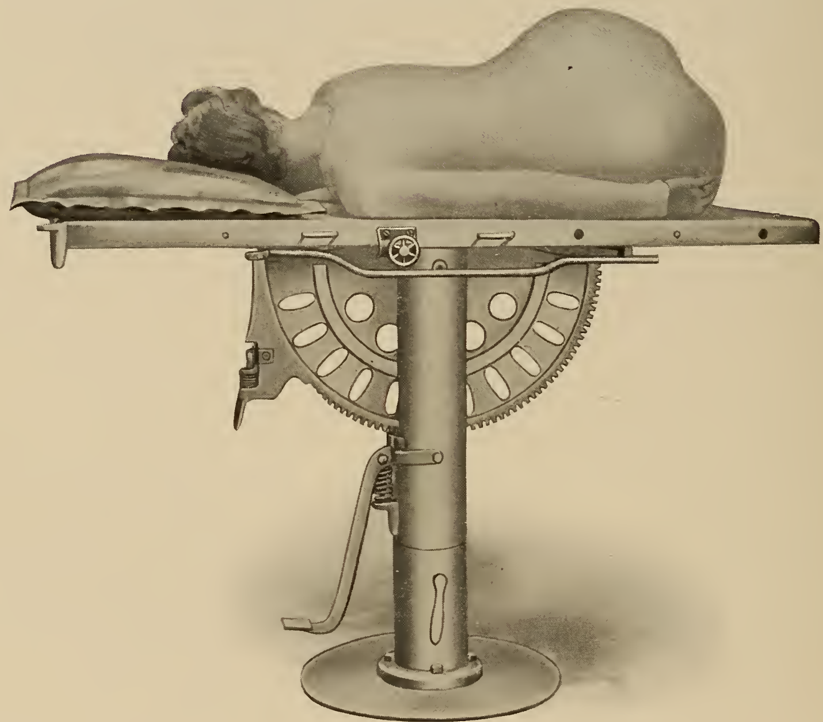

ILLUSTRATION XVII
Sims's Posture (side view)

which will facilitate the accomplishment of our purpose. The following are the most commonly used:

Sims's posture, also called the semiprone, was first brought to the attention of the profession by Dr. Marion Sims. It is thus obtained—

(1) All clothing such as waistbands are loosened.
(2) Place the patient on her left side with legs and thighs partially flexed.
(3) Left arm laying along the back or over the edge of the table.
(4) Right thigh and leg over the left.
(5) The right anterior spine *tilted toward the top of the table.*

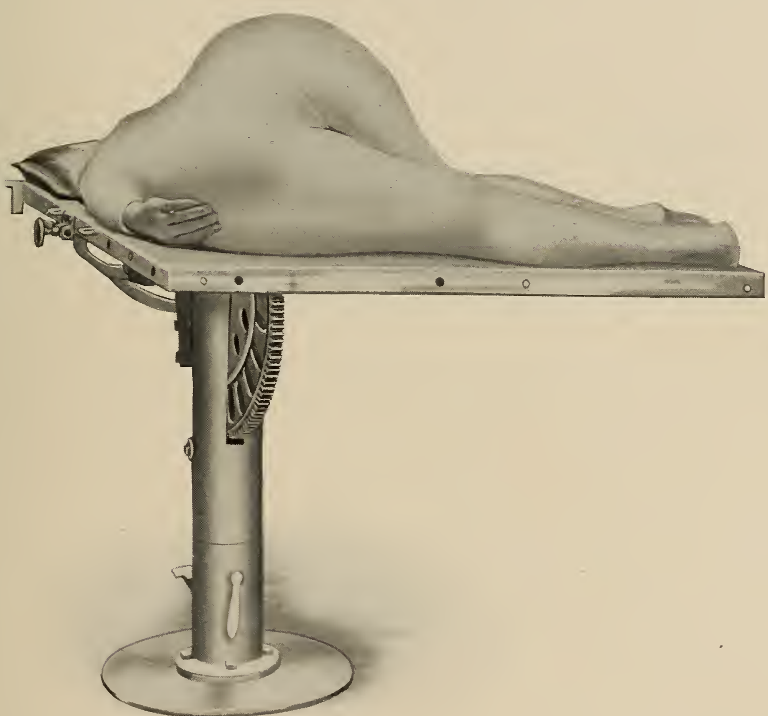

ILLUSTRATION XVIII

Sims's Posture (end view).—Note the incline of the right hip toward the surface of the table.

If a Sims speculum or other vaginal retractor is now introduced in the vagina and the perineum retracted, the canal is at once ballooned with air, and the cervix comes into view. The position is used for examinations, topical applications to the uterus (cervix), and occasionally it is employed for operations on these parts. (See illustrations XVII and XVIII.)

Dorsal Recumbent.—This is the usual position employed for examining patients with abdominal or pelvic diseases. It is obtained thus—

(1) All tight clothing is loosened.
(2) The patient is supine (lying on the back) on the table.
(3) Elevate head and shoulders.
(4) Flex limbs, by placing the patient's feet on the table or in stirrups.

Thus the anterior abdominal muscles are relaxed, which allows a greater depth of palpation,—a closer contact, so to speak, with the abdominal organs. This is the position employed *for bimanual examinations,*—that is to say,

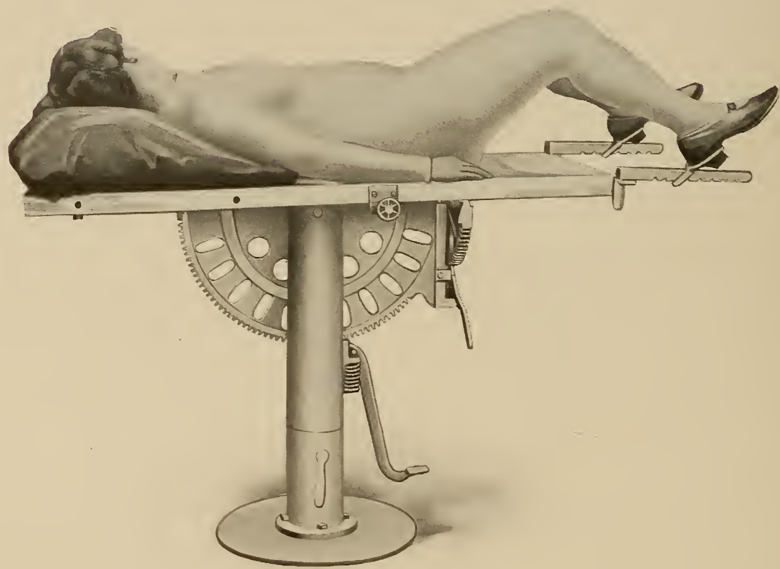

ILLUSTRATION XIX

Dorsal Recumbent Position (side view).—Note the shoulders elevated on a pillow and the thighs slightly flexed to facilitate the relaxation of the abdominal muscles.

one hand of the examiner is placed above the symphysis pubis, crowding the pelvic viscera downward, while the other is in the vagina mapping out any abnormalities that are present. This position is also used in connection with the ordinary bivalve vaginal speculum to administer topical applications to the cervix uteri. (See illustrations XIX and XX.)

Knee-chest Position is obtained by having the patient kneel on the examining-table with the *thighs perpendicular to its surface* while the chest is

brought as close as possible to the plane of the same,—the face being turned to either side to permit this. The philosophy of the position is based on the fact that the intestines gravitate toward the diaphragm, thus relieving the vagina, bladder, and rectum of any superincumbent weight. By the intro-

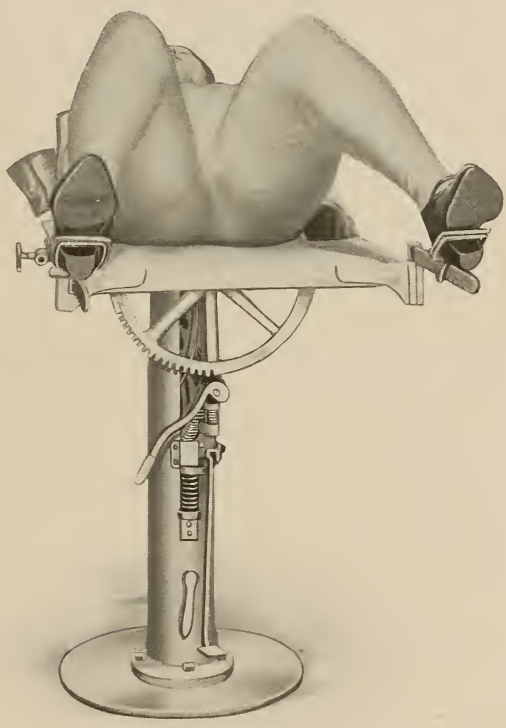

Illustration XX

Dorsal Recumbent Position (end view).—This position is utilized for vaginal examinations.

duction of a suitable speculum, either of these organs are dilated by the in-rush of air, and a thorough inspection can be obtained. The position is frequently utilized in adjusting retrodisplacements of the uterus. If extensive pelvic adhesions are present the ballooning of the hollow viscera will be imperfect. (See illustrations XXI and XXII.)

Dorsosacral, or Lithotomy Posture, is obtained thus—

(1) Place the patient supine on the table.

(2) Locate the buttocks to the edge of the same.

(3) Flex the legs on the thighs and these on the abdomen.

(4) Maintain the position by the usual leg-holders attached to the operating-table or substitute the Clover crutch for these in private practice.

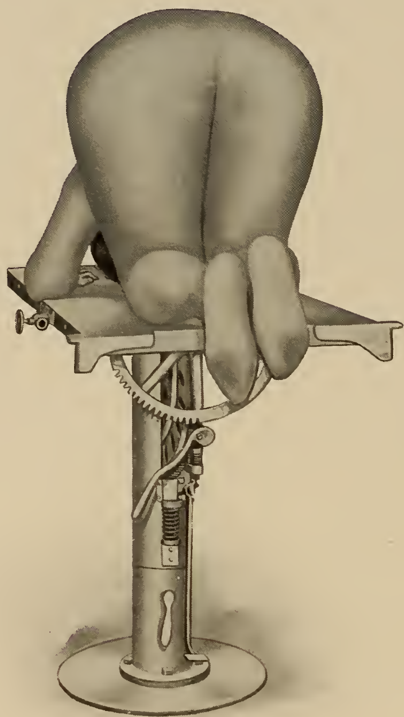

ILLUSTRATION XXI

Knee-chest Position.—Patient on author's table, top flat.

The position is used in operations on the cervix uteri, vagina, perineum, rectum, and in perineal prostatectomies. (See illustrations XXIII and XXIV.)

The Trendelenberg Position.—This posture was introduced to the profession by the surgeon whose name it bears. It consists in the elevation of the

pelvis to an extent that will cause the intestines to gravitate toward the diaphragm; they are maintained in that position by abdominal sponges, thus leaving this basin clear for operative interference. The amount of elevation necessary will vary from 20 to 45 degrees. There are various

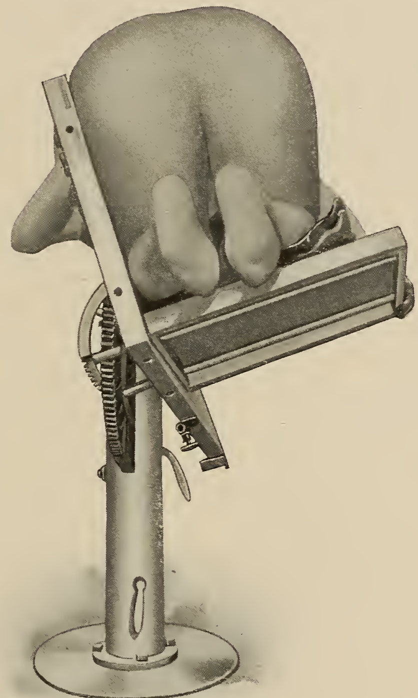

ILLUSTRATION XXII

Knee-chest Position.—Patient on author's table, shelf attachment utilized. Head of the table lowered so as to obtain a better distention of the pelvic organs which are to be examined.

modifications of this position to which it will not be necessary for me to call your attention. The most satisfactory result is obtained in the following manner—

(1) Patient supine on the table.

(2) The flexure of the knees so adjusted as to bring the same to the hinge portion of the "foot-drop leaf" to which the feet are attached, either by a leather strap provided for this purpose or a wide bandage.

(3) The foot leaf is then dropped.

(4) The head of the table is depressed, elevating the pelvis. Thus the patient is retained in position by the flexion of the limbs over the drop leaf to which they have been secured. This is preferable to having shoulder crutches. By referring to illustration XXV you will note that the thorax is not bent forward on the abdomen, which should be considered dangerous,

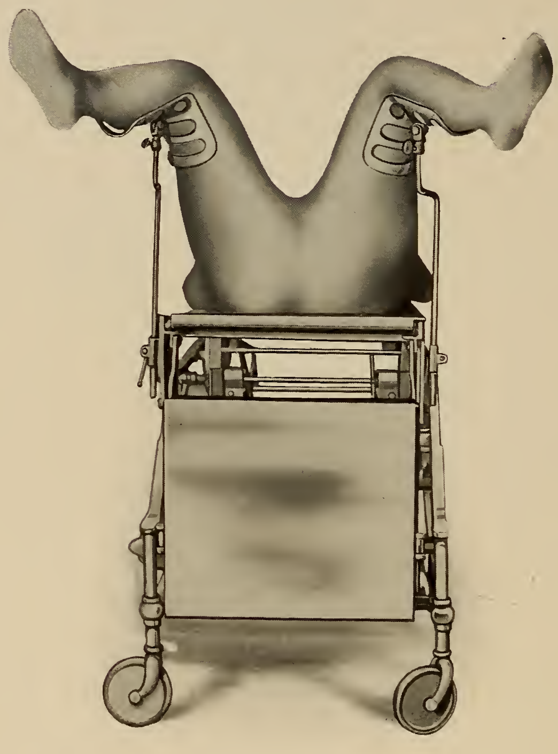

ILLUSTRATION XXIII

Dorsosacral or Lithotomy Posture.—Note the leg-holders. This is the usual manner of obtaining this position in hospital practice.

but is on the same incline plane as the trunk, *allowing free respiration—a point of great importance.*

The usefulness of this position cannot be overestimated in operations in the pelvis, but with the advantages this posture affords it carries with it certain disadvantages, among which may be mentioned—

(1) The pressure of the intestines and omentum against the diaphragm interfering with respiration, especially in obese patients.

(2) The gravitation of infectious material from the pelvis to the higher zones in the abdomen, in other words the spreading of infection.

(3) The danger of secondary hemorrhage. I have on several occasions noted a field free from blood while the patient was in this position, but,

ILLUSTRATION XXIV

Dorso-sacral or Lithotomy Posture.—Note the Clover crutch retaining the limbs in position. This retaining apparatus is frequently used in private practice.

when returned to normal position, hemorrhagic areas at once appeared. (See illustration XXV.)

The Hartley Position.—This posture is named for its originator, Doctor Frank Hartley of New York; it is really a reverse Trendelenberg, and is accomplished in the following manner—

(1) Place the patient recumbent on the table.

(2) Adjust the "foot-rest plate" so that its position corresponds to the soles of the feet, and prevents the subject from slipping when the head is elevated.

(3) Strap the knees to the top of the table to prevent flexion when the patient's muscles relax from the effect of the anesthetic.

(4) Elevate the trunk to an angle of about 30 degrees.

This position is used chiefly in head and neck operations. (See illustrations XXVI and XXVII.)

ILLUSTRATION XXV
Trendelenberg Position

The Fowler Position.—This was first suggested by Doctor Fowler of Brooklyn, and if the Trendelenberg position is a necessity during an operation, the Fowler posture is equally efficacious *before, during, and after operative interference.* It is obtained by *elevating the trunk* 35 degrees to 38 degrees.

Mechanical Ways of Obtaining the Fowler Position.—Method One.—By placing an ordinary back-rest in the bed the necessary elevation can be

obtained, but the tendency of the patient to slide off the "rest" makes this a poor means of obtaining this position; nevertheless it is mentioned inasmuch as circumstances frequently compel its employment.

Method Two.—A device similar to the one shown in illustration XXX is placed under the head of the bed so as to produce the necessary degree of elevation. This method carries the same disadvantage as the former—the difficulty in preventing the patient from sliding toward the foot of the bed.

Method Three.—I hope I may be permitted the latitude of preferring the double-inclined bed-frame which I originated, to any other method that has

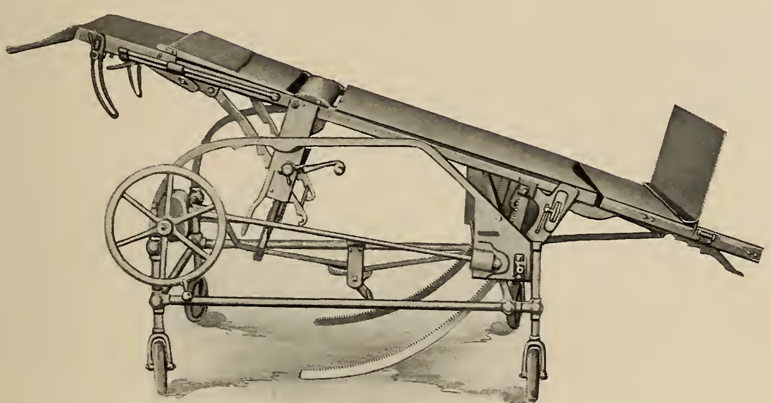

Illustration XXVI

Table in the Hartley Position showing the foot-leaf employed to prevent the patient slipping and the head-rest used in operations on the neck to produce a convexity of that part.

been brought to my notice. A glance at illustration XXVIII will explain its mechanical details.

Advantages of this Bed-frame.—

(1) Being made of steel it can be cleansed.

(2) It is comparatively light, so that it may be easily transferred from place to place by one nurse.

(3) It retains the patient in position.

(4) It relaxes the traumatized abdominal wall and thus affords relief.

(5) It assists rapid venous return from the lower extremities, possibly preventing thrombophlebitis. (See illustrations XXVIII and XXIX. Illustration XXX gives another means of obtaining the same position.)

The Fowler Position is based on anatomic and physiologic principles, among which may be formulated the following—

(1) There is a peritoneal current tending from the pelvis to the diaphragm at all times and under all circumstances irrespective of the position of the subject, whether erect, lying flat, or with pelvis elevated and head down on an incline plane.

(2) This current can be *retarded "by a position opposed to gravity,"* (John L. Yates, M. D.) that is to say, the *nearer the erect posture of the trunk, the slower will be this current.*

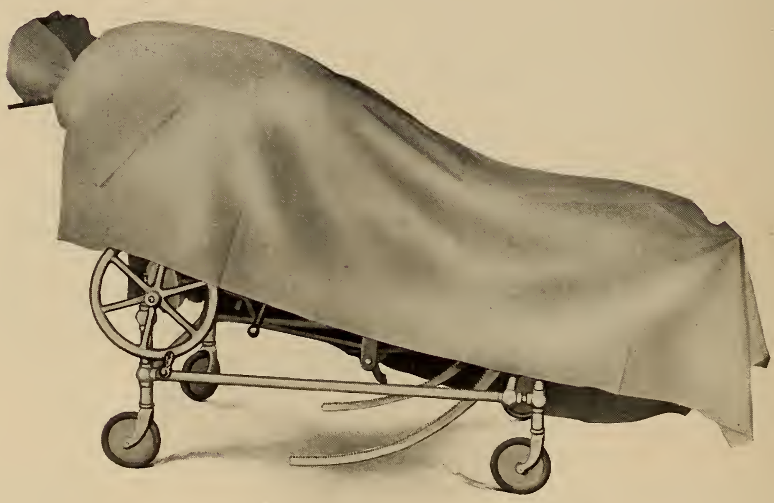

ILLUSTRATION XXVII

Hartley Position.—Note the convexity of the neck of the patient

(3) The pelvis is supplied with *few lymphatics,* comparatively speaking, and is therefore a *harbor of safety* when infection is present.

(4) The region around the diaphragm is richly supplied with these absorbents,—hence a zone for rapid absorption in the presence of infection.

(5) This peritoneal current is promoted by respiration, peristalsis, etc.

The object of the Fowler position therefore is to retard the peritoneal current to the extent that absorption at the diaphragm will be proportionately minimized; thus if there is an infection or infectious material in the pelvis,

the current will carry such infection to the dangerous zone of the diaphragm *so slowly* that when absorption takes place the body-resistance will be more capable of taking care of it than if the current was *given full sway* and allowed to overwhelm the body forces.

When the subject is supine there will be seen a *concavity on either side of the vertebral column below the diaphragm,* the so-called *flanks;* these are separated from the pelvis by a prominence known as the promontory of the sacrum, aided by the psoas muscles. The question necessary to be settled is, what degree will the trunk have to be elevated *to drain the flanks into the pelvis?* During operations in the Trendelenberg posture, infectious

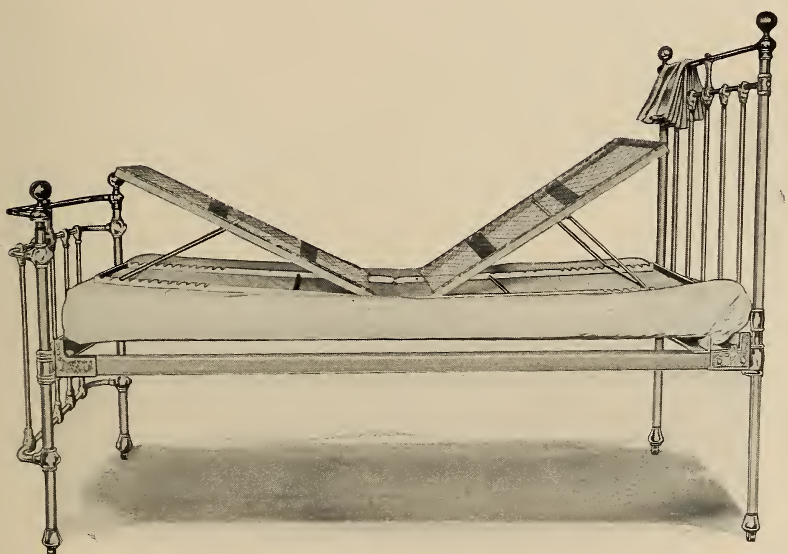

Illustration XXVIII

Showing the author's bed-frame to obtain the Fowler Position

material will gravitate into the flanks, a zone where absorption is rapid, or in operations in the upper abdomen this same accident may occur. I attempted to solve this problem with the assistance of a mechanical engineer. The abdomens of eight cadavers were eviscerated; beginning immediately under the diaphragm, levels were made of the cavity every one-half inch until the lowest portion of the pelvis was reached; the results demonstrated that it required from 35 degrees to 38 degrees of elevation to accomplish this postural drainage. There was little or no difference between male and female subjects. In utilizing the Fowler position these deductions should be

borne in mind as it is common observation to witness some patients nearly erect, and others practically not taken off the plane of the bed; moreover clinical experience has confirmed the fact that the angles I have suggested retard the peritoneal current sufficiently. *But it is not in postoperative cases alone* that the Fowler position should be utilized. *If this posture were more frequently employed in acute intraperitoneal infections, together with gastro-intestinal rest and proctoclysis many cases which are placed on the operating-table at the height of infection could be postponed until such*

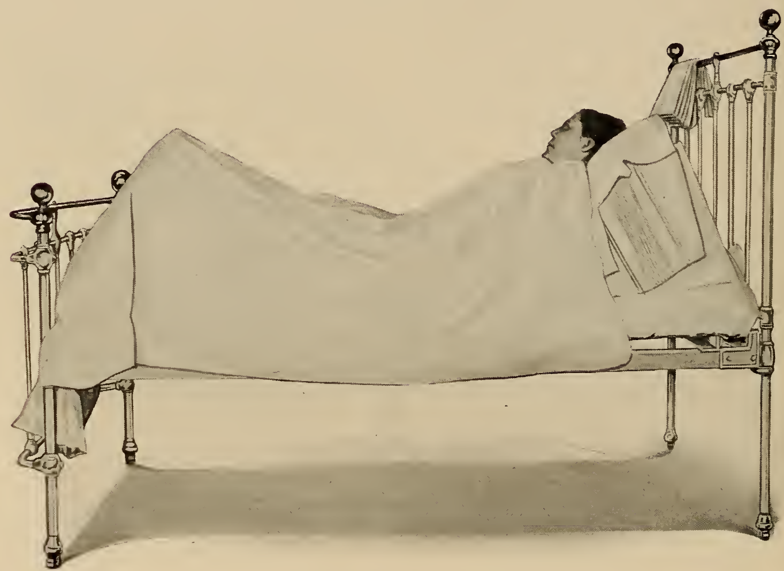

ILLUSTRATION XXIX

Patient in Fowler Position. Author's frame being utilized for the purpose

infection was under control or circumscribed. (See lecture on "Principles and Practice of Postoperative Nursing," sections "Water and Nourishment.") Thus cases of fulminating appendicitis should be placed in the Fowler position *before* operative interference, *maintained* in this posture *during* the operation, and *retained* in the same after leaving the operating-room.

I hardly need state, that in all of these positions, especially those for purposes of examination, the patient should never be unnecessarily exposed.

One of the most distasteful sights is to see a careless nure in this respect,-- *the esthetic should be practiced and vulgar exposure carefully avoided.*

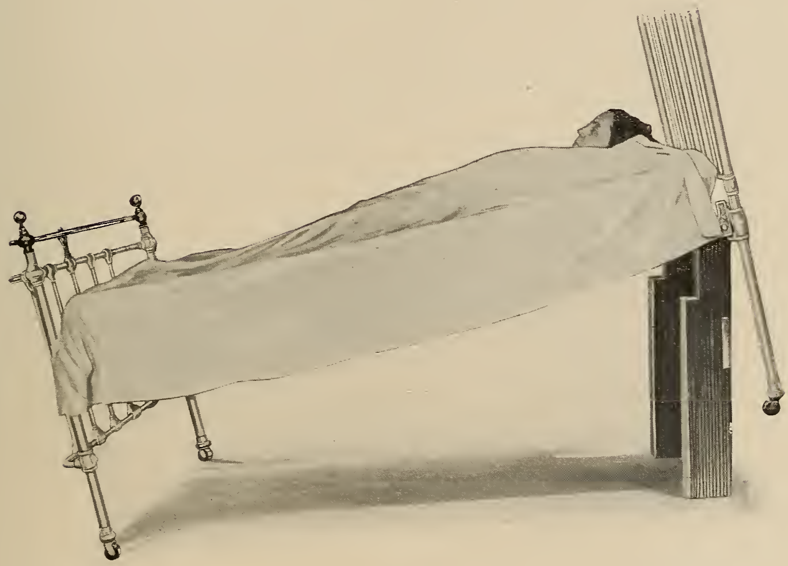

ILLUSTRATION XXX

Patient in the Fowler Position. The mechanical means here illustrated can be utilized in private practice.

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LECTURE X

THE BLOOD-VESSELS

It is not the province of these lectures to deal with the subject of anatomy, but that the discussion of the next few subjects may be more clearly understood, I desire to call your attention to some of the anatomical rudiments of the blood-vessels.

The vascular system may be divided into three divisions, viz., (1) the *arteries* which carry the oxygenated blood from the heart with nutritive material for the tissues, (2) the *veins* which return the deoxygenated blood to the heart after the tissues have received their nutrition from the arterial blood, and (3) the *capillaries,*—the connecting links between the arteries and veins. Where the small arteries end the capillaries begin, and where the small veins begin the capillaries end. The arteries are branches of one large vessel, the aorta, which originates at the upper part of the left ventricle of the heart. This vessel divides and subdivides throughout the economy until it terminates in small twigs. The veins begin at the termination of the capillaries in minute vessels. These increase in size on their way back to the heart by constantly joining with each other until two trunks are formed, the superior and inferior vena cava which empty into the right auricle. The superior vena cava returns the blood from the upper portion of the body, the inferior from all parts of the economy below the diaphragm. The return flow of blood through the veins is therefore laboring under a mechanical disadvantage. The veins are supplied with *valves,* especially in those regions of the body where large columns of blood are present, as in the veins of the extremities. Their function is to prevent any backward movement of the circulation.

The arteries in their course communicate freely with each other, the same is true of the veins; not only is this seen in the larger vessels, but in the small ones as well. The communication is known as an *anastomosis,* or *inosculation.* Thus the branches of an artery or vein above a joint will communicate or anastomose with branches of some other artery or vein below the articulation. Moreover after the circulation has been checked in its usual course by the use of a ligature, as in surgical operations, and the blood-current directed into new paths the increased volume of the blood

causes an enlargement of the vessels through which it passes. When the vessels have sufficiently enlarged to take care of the extra amount of blood which has been forced through them, *a collateral circulation* is said to have been established. You can easily understand how important this is to a surgeon. Occasionally, however, a collateral circulation is not established after the ligation of a vessel, or only partially so; the consequence is (1) the part dies from lack of nutrition, or (2) the part suffers from malnutrition. There are certain arteries that do not anastomose, in which therefore a collateral circulation could not be established should these vessels become occluded; these are termed *terminal arteries.*

Histology (*Minute Anatomy*).—The walls of the arteries possess three coats,—the internal, middle, and external. These are composed of muscular and elastic tissues bound together by connective tissue. The larger the artery, the greater is the development of muscular and elastic fibers. On the free surface of the inner coat, that is over which the blood-current flows, is a delicate, smooth, and polished membrane composed of endothelial cells, the functions of which are (1) to prevent the coagulation of the blood, (2) to reduce to a minimum the amount of resistance to the current,—in other words it is the antifriction surface, (3) to aid in the repair of injured vessels.

The capillaries are composed of a single layer of endothelial cells; the muscular and elastic fibers which were found in the veins and arteries are not present in these tubules.

The coats of the arteries and veins receive their nutrition from minute vessels originating from themselves, known as the *vasa vasorum.*

All blood-vessels are supplied by minute nerve filaments known as the *vasomotor nerves.* These acting on the elastic and muscular fibers of the wall, *contract and dilate the caliber of the vessel according to the needs of the economy,*—more of which will be spoken of in the lectures on "Surgical Shock" and "Hemorrhage."

Lymphatics are also found in the external coat of blood-vessels.

Process of Repair of Blood-vessels.—The *inner coat* of the blood-vessels plays a very important part in the process of their repair. When injured *this tunic* has a tendency to *"curl up" within the caliber of the vessel,* thus causing some obstruction to the blood-current; possibly this hindrance is very slight, yet nevertheless this together with the *elimination of fibrin* (a product of the blood) causes a *clot or thrombus* to form which is the first step in the process of vessel-wound repair. The *endothelium* which lines the inner coat now *proliferates* and *covers this clot;* soon *elastic* and *fibrous cells* from the other coats of the vessel *multiply and penetrate the thickness of the thrombus. Leukocytes,* which are ever present in increased numbers

where an injury occurs or an infection is imminent, *begin their work of removing the clot* which was primarily formed. In this way as fast as the clot is being removed, fibrous and elastic cells from the middle and outer coats are taking its place, until the injury is repaired by these new cells. If the area involved is large, minute vessels from the vasa vasorum penetrate this new tissue to supply it with nutrition. A *process of contraction begins* in these newly formed cells, and a *cicatrix or scar tissue* develops which is the final result of all wounds. (See lecture on "Wounds," section "Repair.")

A process similar to what has been described occurs when a vessel is ligated, that is—

(1) The inner and middle coats are ruptured by the ligature.

(2) The inner coat curls within the caliber of the vessel.

(3) Elimination of fibrin, the result of injury to the inner coat and blood-cells.

(4) Formation of clot at site of injury, due to the second and third steps.

(5) The thrombus or clot is covered with endothelial cells from the inner coat.

(6) Proliferation of fibrous and elastic cells from the middle and outer coats of the vessel.

(7) Penetration of these cells through the clot to form new tissue.

(8) Absorption of clot by leukocytes as rapidly as new elastic and fibrous cells are formed.

(9) Development of minute blood-vessels from the vasa vasorum to supply this newly formed "plug" with nutrition.

(10) Contraction of this new tissue, formation of a scar.

LECTURE XI

TRANSFUSION—INFUSION

The term *transfusion* is limited at the present time to *that process by which the arterial blood of one individual is caused to flow into the veins of another.* The idea itself is old, but fell into disuse on account of what was formerly considered insurmountable difficulties. Through the ingenuity of Dr. Geo. W. Crile of Cleveland, Ohio, it was revived and placed on a practical basis.

You can easily understand that in cases of severe shock, where the blood-vessels are greatly relaxed (see lecture on "Surgical Shock"), or in cases of exsanguination (depletion of blood), no artificial fluid could be injected into the vessels that would compare with normal blood. All the elements of nutrition are found in it. It is the physiologic and natural fluid, *therefore it meets all the requirements instantly;* furthermore, regardless of the amount, *the transfused blood is retained, and does not exude through the coats of the vessels as when saline solutions are administered in large amounts.*

Moreover, transfusion affords the only means at our command of permitting immediate operations on those patients who are either reduced to such a low ebb by protracted disease or by emergencies where further procrastination means a fatality.

The one giving the blood is known as the *donor,* while the recipient is called the *donee.* Like every other innovation it is not thoroughly understood, consequently the results have been disastrous in many cases. It must be borne in mind that the blood of one individual may not be compatible (if I may be allowed that expression) with that of another, *that is to say the blood-corpuscles of the donor may be disintegrated by the blood-serum of the donee and the hemoglobin set free;* a condition known as *hemolysis.* You can easily appreciate therefore the amount of toxemia which is capable of being produced in a transfusion of 500 c.c. of blood if a hemolytic action occurs. In operations where hemorrhage and shock are expected, a test is made of the two bloods to ascertain if hemolysis is present the day *previous* to operation; but in *emergency cases, where the patient is "in extremis,"* there is no time for such a test, and the transfusion is made from *any healthy individual* who will give the blood.

There is no way of estimating the amount of blood transfused; in fact, for practical purposes *it is not necessary.* The object of transfusion is

primarily to raise the blood-pressure. (See lecture on "Surgical Shock.") This being brought approximately to the normal point dissolution cannot take place from shock, hemorrhage, or other surgical emergencies. Blood-pressure is estimated by an instrument known as a sphygmomanometer. (See lecture on "Surgical Shock," section "Blood-pressure.") If one of these is applied to the arm of the donor and another to the donee, the readings will indicate the ascension of blood-pressure in the latter and the descension of the same in the former. When the donee has received a sufficient amount of this fluid to raise the blood-pressure near the normal point, or preferably above it, the transfusion should cease. There is no risk to the donor if the sphygmomanometer is used.

Accessories Necessary for Transfusion.—

(1) 1 sharp scalpel.

(2) 1 pair of dissecting forceps.

(3) 1 blunt dissector.

(4) 6 small hemostats, commonly known as "mosquito" forceps.

(5) 4 Crile carotid clamps.

(6) Assorted sizes of Crile's anastomosis cannulae.

(7) Cocain solution (2 per cent.) and hypodermic syringe.

(8) Needle holder, needles, No. 1 catgut, and No. 000 pagenstecher.

(9) 1 or 2 sphygmomanometers.

Infusion.—By the term infusion as applied to surgery is understood the *introduction into the circulation of normal saline solution.* This may be accomplished in either of the following ways:

(1) *Directly* into the vein, *intravenous infusion.*

(2) By way of the rectum, *proctoclysis, enteroclysis, or rectal infusion.*

(3) Into the cellular tissue, *hypodermoclysis.*

(4) The solution may be introduced into the peritoneal cavity, a locality where absorption is rapid, to which the term *intra-abdominal infusion* is applied.

General Effects of an Infusion.—

(1) It stimulates the circulation by assisting to fill the relaxed vessels in cases of shock, and forms a temporary substitute fluid in cases of hemorrhage,—therefore increases blood-pressure.

(2) It affords a means of giving fluids to the patient when unable to take water by the mouth from physical inability, or when gastro-intestinal rest is required.

(3) It dilutes infectious material when present in the blood-current.

(4) It increases the fluidity and volume of the blood, which together with the rise in blood-pressure stimulates the function of the kidneys; moreover, in infectious diseases, the integrity of these organs is preserved as the result of the dilution of the toxins.

(5) Its presence in the circulation produces a leukocytosis.

An analysis therefore of its various effects demonstrates that it is a great factor in conserving natural resistance.

Intravenous Infusion.—Of the four different ways I have mentioned of getting a saline solution into the circulation, *the intravenous is preferable when a quick and rapid stimulation is the desired end, and time means every-*

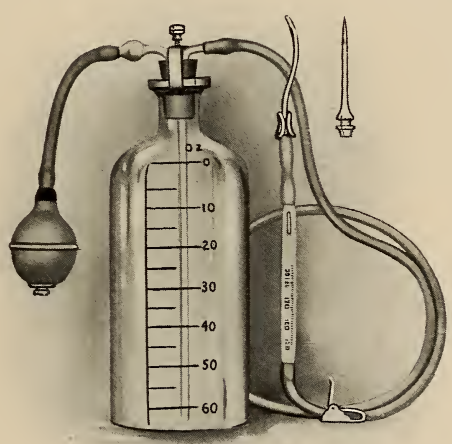

Illustration XXXI
Infusion Bottle with saline solution under air pressure.

thing to the patient, as in cases of shock and hemorrhage; because in this way the infusion is delivered *directly* into the relaxed vessels and fills their lumen *immediately* instead of having to be absorbed before reaching the circulation.

No elaborate apparatus is necessary to carry out this technic; the outfit mentioned in the lecture on "Ward Service," which is always sterilized ready for use, is employed.

Infusion Reservoir.—The numerous complex reservoirs on the market for the administration of the saline solution, to which are attached bulbs or

pumps to produce air pressure, are absolutely unnecessary and occasionally harmful. There is no way of estimating the amount of air pressure, which varies constantly, and *consequently the force of the stream into the circulation changes proportionately*. (See illustration XXXI.)

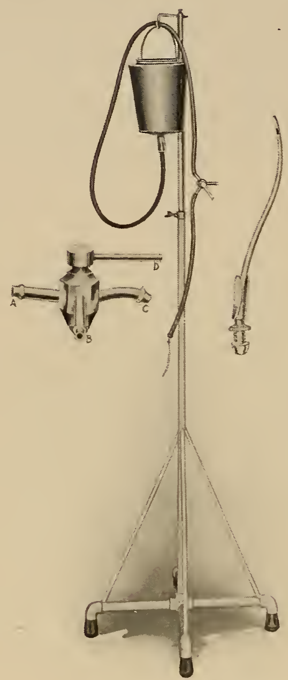

ILLUSTRATION XXXII

Author's Infusion Reservoir.—Note the double jacket which is filled with hot water to maintain the temperature of the saline solution in the glass reservoir; also observe the by-pass stopcock in the tubing leading to the infusion needle. The reservoir is raised or lowered by a telescopic tube which fits in the standard.

The reservoir I prefer is simply a graduated glass percolator, suspended at a variable height, equipped with rubber tubing, the necessary needle, and a by-pass stopcock. The by-pass indicates at any time during the operation the rapidity of the flow. The reservoir can be raised or lowered to increase or diminish the current. Frequently when administering an infusion for shock or hemorrhage, it is necessary to allow the current to flow *rapidly at*

first for its stimulating effect, and *gradually modify* the *outflow through fear of blocking the heart's action.* This cannot be accomplished with the same precision when using air-pressure bottles. (See illustration XXXII.)

Infusion Needles.—There are two varieties, sharp and dull pointed; the latter occasionally have an olive-shaped tip. The sharp-pointed needles should not be used. The ease with which the coat of the vessel can be punctured by any sudden move of the patient is sufficient reason for rejecting them.

Choice of Location for Intravenous Infusion.—Any superficial vein can be used for infusion. Usually one on the anterior surface of the elbow (median bacilic or median cephalic) is chosen.

Inasmuch as the surgeon performs the operation of infusion I will pass to the duties of the nurse.

Nurse's Duties.—

(1) Obtain a complete infusion outfit as described in "Ward Service."

(2) Heat one of the flasks containing the normal saline solution.

(3) Carefully remove the outer wrapper of the package containing the accessories. Avoid soiling the inner wrapper.

(4) Cleanse hands, adjust gown and gloves.

(5) Prepare the field for infusion according to one of the methods described, protecting the arm and forearm above and below the field with sterile towels moistened in mercuric solution 1:2000.

(6) Arrange sterile towels in such a manner that the field is not contaminated by contact with bedding, etc.

(7) Encircle the arm *above the field* with a bandage snugly applied. This brings the veins prominently into view.

(8) Prepare cocain solution according to surgeon's directions (generally 2-per cent. solution). If the patient is unconscious this step is omitted.

(9) Partially fill the reservoir with the hot saline solution; modify the temperature with the cold solution until the thermometer (which is placed in the reservoir) indicates 120°F.

(10) Add 30 minims of solution adrenalin chlorid to every pint of infusion fluid.

(11) Care should be exercised by the nurse *to ascertain if all air is expelled from the tube and needle* before giving it to the surgeon to introduce into the vein.

(12) Release the bandage with which the arm is encircled after the surgeon has secured the needle in the vein.

(13) Keep the field moistened with warm saline solution to prevent clotting of the blood.

(14) Pay strict attention to the pulse. If improvement is noted, it indicates the heart is capable of handling the extra fluid that is being thrown into the circulation, but if on the contrary the pulse becomes weaker, it is an indication that the heart is being "overcrowded." *The nurse should then cease administering the infusion by shutting off the stopcock and notify the surgical attendant* if this latter is not present.

(15) As soon as the desired amount (about two pints) is administered the surgeon ligates the vein and closes the wound; the nurse cleanses the arm and applies a sterile dressing.

Frequent Modification.—When during the administration of an intravenous infusion, an *immediate and pronounced effect of adrenalin chlorid* is needed (as in severe cases of shock and hemorrhage), the surgeon will inject by means of a hypodermic syringe a few drops (5 to 10) of the drug *into the main tube of the irrigator about an inch above* the intravenous needle. This is in addition to the adrenalin chlorid contained in the saline infusion.

Proctoclysis—Enteroclysis or Rectal Infusion.—Some one has said, "we eat by means of the small intestines, and drink through the medium of the large bowel." That is to say, the material contained within the duodenum, jejunum, and the ileum is of a semifluid consistency, but during its passage through the colon, sigmoid, and rectum absorption of the fluid portion occurs. This primitive knowledge was the basis on which our present principles of proctoclysis were developed.

To Dr. John B. Murphy the profession is indebted for the proper technic of rectal infusion, and the demonstration of its vast field of usefulness. The method which he advocates is based on *physiologic principles* and supplemented by the *laws of physics.* The following essentials as set forth by Dr. Murphy must be thoroughly understood to successfully administer a proctoclysis:

(1) The fecal material enters the large intestine in a semifluid state. In its passage through this portion of the gut the fluid is extracted by absorption. The large bowel therefore is a "dryer" of the alimentary canal.

(2) The natural condition of the large intestine is one of distention.

(3) The material in the large bowel is held under low tension,—about *a four-inch hydraulic pressure; this is increased possibly to a six-inch pressure in the presence of an inflammatory condition within the abdomen.*

(4) *If this tension or pressure is increased it causes a spasm of the bowel and discomfort, which is relieved only by expulsion of the material which developed the abnormal tension.*

The deductions drawn from these physiologic principles, and which have been corroborated by clinical experience, are—

(1) That the large intestine is capable of rapidly absorbing large volumes of bland, isotonic fluids—sixteen to thirty pints per day.

(2) That expulsion of the fluid (no matter how rapidly it is given) will not occur if the increased pressure caused by its presence within the gut does not exceed a four-inch hydraulic pressure; or possibly a six-inch pressure

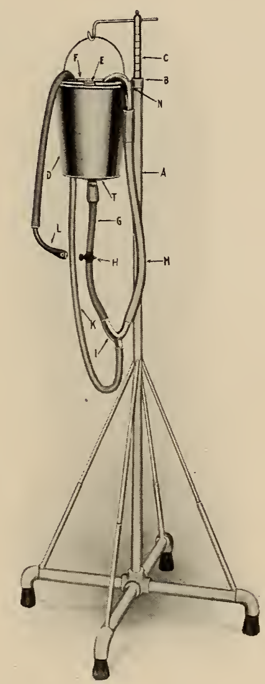

Illustration XXXIII
Author's Proctoclysis Outfit

when a general inflammatory condition is present within the abdomen (a peritonitis). Furthermore, the *fluid will not flow in rapidly with that pressure because it meets with an equal tension or pressure within the bowel,* therefore the outlet of the reservoir containing the fluid should *never be more than six inches above the level of the rectum.*

(3) That a fluid admitted in the bowel by the drop or any other method, when it accumulates there, attains *a pressure equal to the hydraulic pressure*

produced by the height of the reservoir; and if the outlet of the reservoir is elevated more than four to six inches the pressure in the intestine will be increased to such an excess as to cause an expulsion of the fluid.

(4) That if the pressure within the large intestine is increased above normal *by the formation of gas within the intestine when the fluid is being admitted* the bowel will endeavor to expel it.

(5) That the fluid of choice for proctoclysis is the physiologic saline or normal salt solution, because

(a) It is bland and isotonic.

(b) Its presence in the bowel does not produce irritation nor cause the epithelium to become swollen as when plain water is used.

(c) Large volumes are therefore capable of being absorbed. (See lecture on "Preparation and Sterilization of Gowns," etc., section "Normal Salt Solution.")

Types of Apparatus for Proctoclysis.—There are numerous varieties of apparatus for the administration of saline infusion into the rectum,—the complicated types are unnecessary. A simple and convenient apparatus is seen in illustration, the design of which is based entirely on Dr. Murphy's ideas. No originality whatever is claimed *excepting possibly* the method of keeping the saline infusion warm, and the graduated standard which regulates exactly the height of the reservoir—*a point of great practical importance.*

Requirements for a Proctoclysis Outfit.—This may be termed a *double-tube* apparatus inasmuch as a safety return tube is used. (See illustration XXXIII.)

(a) A standard made from steel tubing.

(b) A check-nut.

(c) An extension-rod which telescopes in the tube (a) and is maintained at any desired height by the check-nut (b). This extension is graduated in inches, and indicates the exact height of the reservoir.

(d) A double copper jacket filled with hot water to maintain the temperature of the saline solution in the glass reservoir.

(e) The inlet for hot water in the double copper jacket.

(f) Glass percolator (surrounded by the double copper jacket) as a reservoir for the normal saline solution.

(g) Main outlet from the reservoir of rubber tubing one-half inch in diameter.

(h) Stop-cock to regulate the flow.

(i) Glass Y, one-half inch in diameter.

(k) Rubber tubing, one-half inch in diameter, connecting glass Y (i) with rectal nozzle (l).

(l) Rectal nozzle of glass or hard or soft rubber. The material is of little consequence providing it is so constructed that it contains at least five holes, each of which is one-eighth of an inch in diameter. These several openings are made large, not to facilitate the solution entering the rectum, *but to afford a free exit from*

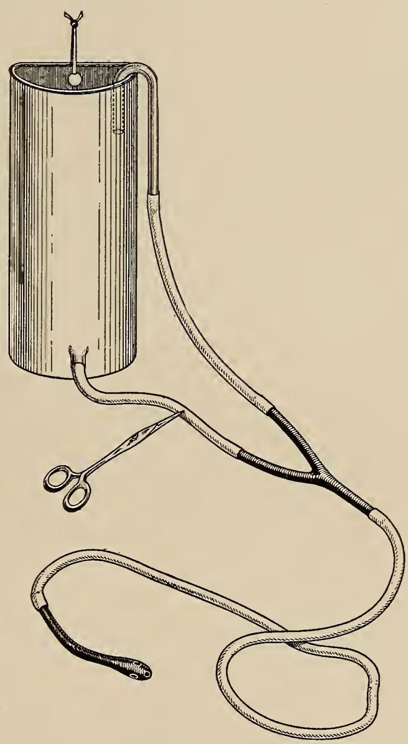

ILLUSTRATION XXXIV
An Extemporized Proctoclysis Outfit for use in private practice.

the bowel for any material which is ejected by an expulsive action of the intestine. The nozzle must be curved at such an angle as to easily lay within the rectum and not cause pressure on the walls of that organ.

(m) Safety return tube (half-inch rubber hose).

(n) Glass tube terminal (one-half inch in diameter) of safety return tube, hooked over the upper end of the glass reservoir. *When*

because of increased pressure within the intestine an expulsive action takes place, the fluid passes through the large openings in the rectal nozzle (1), through the left arm of the glass Y, through the safety tube (m), and finally empties back into the reservoir—the path of least resistance.

Description of Illustration XXXIV.—This is simply an extemporized apparatus suggested by Dr. Murphy for use in private practice, the only difference from the preceding outfit being the following:

(1) An ordinary porcelain douchecan is used as a reservoir.

(2) The saline solution is kept warm by Turkish towels wrapped around the can.

(3) A hemostat is used in place of a stopcock.

To the thoughtful student who has given this subject any consideration, two questions must necessarily arise.

(1) What is the need of a stopcock if the reservoir is suspended at a correct elevation (four to six inches), so that the pressure of water flowing into the bowel is practically equivalent to that within the intestine, the rapidity of the current *from the nozzle being controlled by the pressure within the gut?*

(2) What is the necessity of having a safety return tube if *the main outlet tube is sufficient to care for the back-flow if any occurs?*

The answer is, to equip the apparatus in such a manner as to make it "fool-proof," if I may be permitted to use the expression.

The Murphy proctoclysis may be successfully administered with a *single-tube* apparatus if the following cardinal points are observed:

(1) The suspension reservoir must never exceed six inches from the plane of the rectum, in many cases a less degree of elevation is advisable.

(2) The tube which answers *the double purpose as an inlet for the saline solution to the rectum and as a back-flow from that organ in case of bowel spasm, must have a caliber of at least one-half inch.*

(3) The rectal nozzle must be of ample bore and constructed with at least five holes, each of which is one-eighth inch in diameter, so as to permit free exit of any fluid when the tension within the bowel is increased.

(4) *No hemostat or stopcock is permissible to regulate the flow.* These mechanical appliances so constrict the single tube as to obstruct the back-flow, should spasm of the bowel ensue. The contents of the intestine as usual would take the path of least resistance, which in this case would be at the rectal sphincter. *The flow in a single-tube infusion apparatus must be*

regulated solely and entirely by the height of the outlet of the reservoir (four to six inches) and pressure within the intestine.

Administration of a Proctoclysis.—Nurse's Duties.—

(1) The position of the patient in bed does not interfere with the administration of a rectal infusion; that is to say, the patient may be supine, on

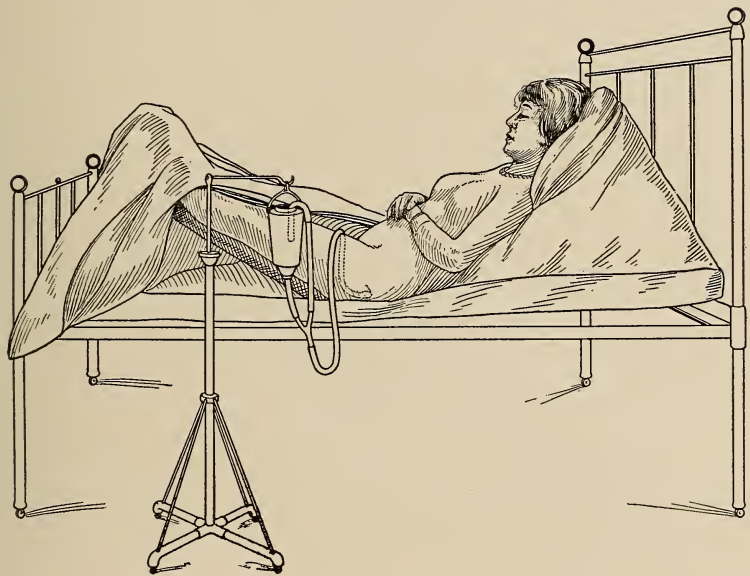

ILLUSTRATION XXXV

Proctoclysis Outfit in Position.—Note the height of the bottom of the reservoir as to the rectum—four to six inches—not suspended one to two feet above that organ as is commonly witnessed.

the side, in the Fowler position, or in the "head-down" or "foot-elevated" position.

(2) Prepare suspension reservoir according to one of the methods suggested above.

(3) Fill the reservoir with normal saline solution at a temperature of 105°F. This is regulated by a thermometer placed within the reservoir.

(4) Suspend the reservoir so that the bottom is from *four to six inches above the rectum. There should be no guess work regarding the height of suspension. If an inflammatory action is present, or much distention of the bowel, a six-inch elevation is permissible, otherwise any point between that*

and four inches. Permit the flow from the reservoir to expel all air from the tube.

(5) Insert the nozzle in the rectum *and do not remove it with each* infusion, but allow it to remain in place. The constant inserting and removing produces an irritation of the organ and finally causes intolerance.

(6) Make provision for keeping the saline solution in the reservoir at 105°F. if the apparatus is not provided with such means.

(7) Secure to thigh the tube leading to the rectum with straps of adhesive plaster about three inches above the rectal nozzle. (See illustration XXXV.)

To the amateur and to those who do not understand the philosophy of the law of physics which I have endeavored to explain with regard to the pressure of the current being maintained at an equivalent pressure to that which exists within the bowel, viz., a four- to six-inch hydraulic pressure, the use of the stopcock becomes a necessity in connection with a safety-tube equipment. To this class my advice is to regulate the flow by the use of the stopcock to about three drops per second previous to its insertion into the bowel and suspend the reservoir four to six inches above the rectum. The average person does not appreciate the increased pressure produced in the bowel by elevating the reservoir *an additional inch,* otherwise more care would be exercised in its adjustment.

I can think of no one adjuvant which has been given to the profession that has a wider range than proctoclysis. Its true value has not yet been appreciated. The lack of knowledge of the fundamental principles involved in its administration has prevented it assuming the important position which it is destined to occupy. In order to obtain the desired effects from a proctoclysis sufficiently large volumes of the infusion must be absorbed, because its action is more or less mechanical. The failure to obtain absorption of the desired volume is due to an improper technic. Only those who have carefully studied the subject and have been successful in its administration, can appreciate its extensive field of application. I am fully aware that after a certain amount of infusion has been thrown into the circulation transudation occurs from the vessels and the deeper viscera, and consequently only a certain amount is *primarily* absorbed. That portion which has transuded is reabsorbed, again thrown into the circulation, and eventually eliminated, carrying with it the toxins and other waste products with which the fluid has come in contact. Thus a continuous cycle of absorption, transudation, reabsorption, and finally elimination through the kidneys is occurring within the economy. The kidneys in this process are protected by the dilution of the toxic material, which otherwise would produce such pathologic changes in their structure as to compromise their function. It is

advisable therefore to cease the administration of a proctoclysis at definite intervals to permit the reabsorption of such portions as have transuded.

In this connection Dr. Murphy says: "We give a pint and a half of normal salt solution every two hours, and so arrange the elevation of the can that it takes an hour or an hour and a quarter for that quantity to flow in. If the drop method is arranged that means about 45 drops in 15 seconds."

Subcutaneous Infusion—Hypodermoclysis.—I consider it a difficult matter to find a suitable field for the use of a hypodermoclysis. If the patient is *"in extremis"* from shock or hemorrhage, the *intravenous infusion is certainly the method of choice* when blood for transfusion cannot be obtained; while if the condition of the patient demands a saline infusion, *yet the case is not an emergency,* when time is not an important element, then proctoclysis as practiced after Dr. John B. Murphy's method is preferable.

Disadvantages of Hypodermoclysis.—

(1) Absorption is comparatively slow at all times, and in some cases a sufficient amount of the solution will not be absorbed.

(2) The process is painful.

(3) If great care is not exercised, the pressure of the fluid on the surrounding tissues may cause a *devitalization and slough;* this is especially true in obese subjects.

Choice of Location for Hypodermoclysis.—The sites for the subcutaneous introduction of normal saline are under the mammary glands in the female, in the loose cellular tissue at the side of the scapula or in the subcutaneous tissues of the flanks in the male.

Accessories Necessary for Hypodermoclysis.—

(1) Infusion needle, sharp-pointed, medium size.

(2) One flask of hot and one of cold normal saline solution.

(3) Suspension reservoir as described in section on "Intravenous Infusion."

(4) One bath thermometer.

(5) Hypodermic syringe and solution cocain (2 per cent.) for local anesthesia.

(6) Ethereal collodion.

(7) Two packages of ward dressings.

(8) Solutions and antiseptics for cleansing the field.

In some hospitals, the head nurse of the floor is allowed to administer subcutaneous infusions. This is proper: she has had experience on account of her service; she appreciates the flow must be regulated in proportion to

the absorption, and the temperature maintained in the reservoir. In private practice *circumstances may arise* which compel the nurse to resort to *this method* of stimulation in the absence of the surgeon. I will therefore describe the method of administration.

Method of Administration.—Nurse's Duties.—

(1) Cleanse hands, assume sterile gown and gloves.

(2) Cleanse field for infusion according to one of the established rules.

(3) Protect field by judicious use of towels placed about the patient.

(4) Cocainize the area in which the infusion needle will enter. (Using 2 per cent.)

(5) Partially fill the reservoir with the hot saline solution; modify it with the cold until a temperature of about 115°F. is obtained, which must be kept at this point throughout the operation. Two pints are generally used. *Note the absence of the solution of adrenalin chlorid* in the composition of the above. *The stimulating effects of this drug are only obtained when introduced directly into the vessel, otherwise its action is purely local.* The temperature of the solution in the reservoir is higher than that used in proctoclysis, because the fluid must enter the tissues very slowly.

(6) Introduce the needle into the cellular tissue of the part selected for the infusion, care being exercised to expel all air in the tube.

(7) Regulate the flow in proportion to the absorption of the fluid. If the solution is deposited in the cellular tissue faster than it is absorbed, the pressure thus exercised may cause a slough.

(8) During the administration of the solution, the field and surrounding tissues should be massaged to induce absorption.

(9) When the desired amount has been given the needle is withdrawn, the hole or exit sealed with collodion, and a small dressing applied, held in place by adhesive plaster.

Intra-abdominal Infusion.—Formerly after abdominal operations some surgeons infused from one pint to a quart of normal salt solution in the peritoneal cavity, with the following objects in view:

(1) To dilute infection and cause rapid absorption, thus hoping to prevent peritonitis.

(2) To produce a stimulating effect on the circulation and thus increase the urinary secretion.

(3) To relieve thirst.

(4) To prevent peritoneal adhesions.

This method is seldom used at the present time; no advantages can be gained by its use.

LECTURE XII

SURGICAL SHOCK

One of the most important subjects in surgical literature is Shock, and as nurses you should understand some of the underlying principles and phenomena connected with this complex condition. To Dr. G. W. Crile of Cleveland, Ohio, the profession owes a lasting debt of gratitude for his investigations and conclusions along these lines. Wherever surgery is taught, or medicine is practiced, the name of this incomparable investigator is linked with this symptom complex, and therefore whatever deductions, conclusions, and statements I may make are to be attributed entirely to what he has given us.

Blood-pressure.—Shock may be defined as a *partial or complete paralysis of the vasoconstrictor center in the medulla, causing such a dilatation of the blood-vessels as to produce an abnormal decrease in blood-pressure. Fall in blood-pressure is the keynote.* It is therefore necessary for me to endeavor to explain to you what is meant by this term. *Blood-pressure is the amount of pressure produced by the blood in the blood-vessels.* This depends on several factors, chief among which may be mentioned (1) *the condition of the vasomotor center which is situated in the medulla;* (2) *the amount of force exercised by the left ventricle of the heart in propelling the blood through the systemic circulation, and* (3) *the condition of the blood-vessels* through which the blood circulates.

Take the radial artery at the wrist of a subject as in the act of counting the pulse; the amount of pressure exercised to obliterate the pulsation is really the blood-pressure, minus the pressure it requires to compress the wall of the vessel, but inasmuch as the tactile touch is not accurate enough to define the amount of pressure made to accomplish this object, some sensitive mechanism must be substituted. This apparatus is known as a *sphygmomanometer.*

The pressure of blood in an average normal adult should be capable of raising a given column of mercury to a height varying from 110 to 130 m.m.

Hence, in stating blood-pressure it is expressed in mercurial millimeters thus, m.m.Hg.

Vasomotor Nerves.—Surrounding the blood-vessels of the body are minute nerve filaments distributed to the muscular tunic or coat, known as the *vasomotor;* some of these filaments *dilate the caliber* and are known as the *vasodilators,* while *others contract* the bore of the vessels and are known as the *vasoconstrictors,* the two acting in harmony maintain the vascular elasticity or tone. The *chief center* or "home office" of the vasoconstrictors is in the upper portion of *the medulla,* besides which there are *secondary centers* or "substations," so to speak, *in the spinal cord.* In health, *the medullary center* in all probability carries on the function independent of the accessory spinal centers, but experiments have shown that when this chief center has been obliterated, the secondary spinal centers eventually pick up the work and maintain the tone of the vessels,—a very important point to remember.* With these physiologic and anatomic data in mind, the consideration of shock may be continued.

Causes of Shock.—*Trauma.*—Surgical shock is associated with various forms and degrees of trauma. In using the word *trauma,* I do not necessarily mean a single or severe injury alone, but I desire to include a *series or multiplicity of minor injuries, which collectively* induce this condition. Shock may be produced by the mangling of a large surface of skin, the rough handling of tissues during an operation that is associated with some hemorrhage, exposure and duration of operative procedures, and the depressing effects of the anesthetic. So that in operations rapidity of work compatible with thoroughness, gentle manipulation of the tissues, protection from exposure to the extremes of temperature, careful hemostasis and the use of as little anesthetic as possible, *all tend toward the conservation of the patient's resources.*

Hemorrhage enters into the etiology of this condition to a very great extent and as Crile puts it, "a long bloodless operation is much less serious than a short and bloody one."

Tissues Involved—Innervation of Part.—Injury to, or operative interference on certain tissues, are more liable to produce shock than the same causes on other tissues,—all depending on the *amount of innervation to the traumatized area.*

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* Some authorities deny the presence of vasodilators, claiming that the vasoconstrictors accomplish both functions by contraction and relaxation. This probably is the true hypothesis, because other muscular structures do not have two innervations,—one to relax and the other to contract.

Crile's observations indicate that the *greater the nerve supply* of any part, the greater is the liability to shock. In short *one of the chief factors in the production of shock is the excessive or prolonged stimulation of nerve tissue.*

Personal Equation of the Patient.—This will have an important bearing in the production of shock. *The aged,* with the usual degenerative changes, naturally are susceptible to shock. *The highly nervous* individual who is always in a state of hyperesthesia is a fit subject to invite this condition. Subjects of *the different sedentary occupations,* individuals with overtaxed brains and lack of normal exercise, are predisposed.

Psychic Causes.—These are well-known factors in the production of shock, especially *in accident cases.* The subject may think an injury is inevitable, possibly a fatality. He instantly becomes unconscious; no injury may have been received, no pain suffered, yet the impression made on the cerebral centers has so disturbed the centers in the medulla as to produce shock: fear being the predominant factor. Death can occur in this manner.

The fear of an *anticipated operation* often acts as a predisposing cause in the production of shock, and accounts for this condition developing after operative procedures of practically minor importance.

The Theory of the Production of Shock.—After a severe or prolonged impression is made on the nervous system by physical or psychical causes, *a paresis or exhaustion occurs in the vasomotor center* in the medulla. The millions of these small nerve filaments which surround the blood-vessels cease to functionate to a greater or less extent, *the tone of the vascular system is lost* proportionately, and the former vessels which were *capable of dilatation and contraction* now become more or less helplessly relaxed, *and their caliber enormously increased.* They are no longer blood-vessels capable of functionating,—simply channels of blood, the current of which is becoming less and less. Sooner or later if this condition is not relieved, the circulation if it may be termed such, becomes a matter of gravity tending in the direction of least resistance—*toward the large abdominal vessels* (the splanchnics) *which alone are capable of holding in their relaxed state the entire amount of blood in the body. The heartbeats are becoming more feeble and faster every moment,* because there is not sufficient fluid within its cavity to stimulate its action. *The blood-pressure is dropping in proportion to the feebleness of the heart's action.* The respiration is sighing and shallow, due to the fall in blood-pressure around the centers controlling this important function. The face loses its normal color and cold, clammy perspiration is present: the former the result of the blood draining to the large abdominal vessels, the latter due to the loss of nerve influence. The general muscular structure is relaxed, the cheeks shrunken, the eyes are deep set, the bridge of the nose is pinched and more prominent, the extremi-

ties are cold and lifeless. *The body-temperature falls below normal.* Pain is absent, and the centers of sensation are abolished because of lack of blood-pressure. All the vital processes are slowly ebbing away, until the patient succumbs. There are other theories which have from time to time been enunciated as to the philosophy of shock, but none that are as well founded or which have stood the clinical test.

Such are the phenomena of shock in its fatal form. Various shades of the picture are seen, from the simple sincope or faint that is caused by a temporary cerebral anemia, to the fatal form which I have tried to depict.

A Comparison Between Shock and Hemorrhage.—A careful analysis of this subject must impress the student that the symptoms of shock closely resemble those of hemorrhage—*in fact, frequently it is impossible to differentiate shock from concealed hemorrhage.* The pallid face of shock has its counterpart in hemorrhage; the rapid pulse in the one, is also seen in the other; the sighing respiration, cold extremities, and bluish-colored nails are common to both; air hunger is present in shock as well as hemorrhage; blood-pressure falls alike in either condition. Both conditions generally arise immediately after operative measures yet they may occur later (*delayed shock*). This is the natural sequence, *for in shock the blood although normal in amount is insufficient to fill the greatly dilated vessels, while in hemorrhage the vessels although of normal caliber have not sufficient blood within to fill them. Shock is really blood-vessels bleeding within themselves, while hemorrhage is a blood-vessel leaking outside. In shock the large abdominal veins act as reservoirs to receive the gravitating and practically currentless blood, while in hemorrhage the tissues without act as basins to retain the leaking current.*

Treatment of Shock.—This can be divided into three parts—

(1) Prevent further shock.

(2) Support the circulation.

(3) Maintain rest.

The Prevention of Further Shock.—This will depend on the cause of the condition. If the patient is undergoing an operation and there is a rapid fall of blood-pressure the anesthetic should be withdrawn, and if possible the operation postponed for future completion. If an accident has caused vasomotor paresis a small amount of morphin is administered hypodermatically in an endeavor to block any further impression on the circulatory centers.

Support the Circulation.—This may be accomplished in three ways—

(1) By transfusion.

(2) By the introduction of solution adrenalin chlorid *alone* into the circulation, or *in connection with* an intravenous infusion.

(3) By mechanical means.

Transfusion.—This is the ideal. No more efficient means is known, or possibly ever will be; every indication is met by its use. The effects are immediate, the patient who is moribund is instantly restored to practically a normal condition and remains so. The only disadvantage possibly that can be attributed is the inability always to obtain a donor. (See lecture on "Transfusion—Infusion.")

Solution of Adrenalin Chlorid—Intravenous Infusion.—This is administered directly into the vein (dose 15 m.). A better plan, however, is in combination with a saline infusion (ʒ 1 to pts. 2) because two benefits are derived: (1) The stimulating effects of the adrenalin are immediately manifested. (2) The volume of infusion fills the calibers of the relaxed vessels. (See lecture on "Transfusion—Infusion.") Adrenalin solution, as I have said, *must be given directly into the vein to accomplish its purpose.* If administered subcutaneously its effects are purely local, if by the mouth the drug never reaches the circulation.

The hypodermatic employment of strychnin sulphate may be tried. The administration of nitroglycerin is *absolutely against common sense*: this drug is a vasodilator and the pathologic condition we are dealing with is one of *exaggerated dilatation.* What can therefore be accomplished except harm? Ergot has been tried frequently with negative results. So we must not waste valuable time waiting for effects from these drugs.

Mechanical Means.—Following the method of Crile, the circulation may be mechanically supported by applying folds of cotton wadding to the extremities, and a large compress from similar material over the abdomen, which are held in place by snugly applied bandages. (I have on several occasions utilized a small pillow doubled on itself for the abdominal compress, maintaining it in position in a like manner.) Far better than this, but unfortunately very seldom at hand when needed, is the Crile pneumatic suit, which envelops the entire body to the neck. After being adjusted it is inflated with air to the desired pressure. This accessory affords the advantage to the operator of increasing or diminishing at will the pressure exercised on the vessels. The philosophy therefore which has been given relative to the support of the circulation is this: The relaxed blood-vessels are filled either with blood derived from another or normal saline with adrenalin chlorid, both of which will cause an increased pressure from within, while

the compresses that have been made, or the pneumatic suit which has been adjusted, tend to constrict the caliber of the vessels from without.

Another important auxiliary in aiding the impoverished circulation is *position.* The foot of the bed should be elevated (about 30°) to encourage cerebral circulation and assist blood-pressure around the vital centers, at the same time *applying artificial heat.* (See illustration XXXVI.)

Rest.—Both *mental and physical rest* are essential elements in the treatment of shock. To accomplish the latter, the patient should be put to bed in

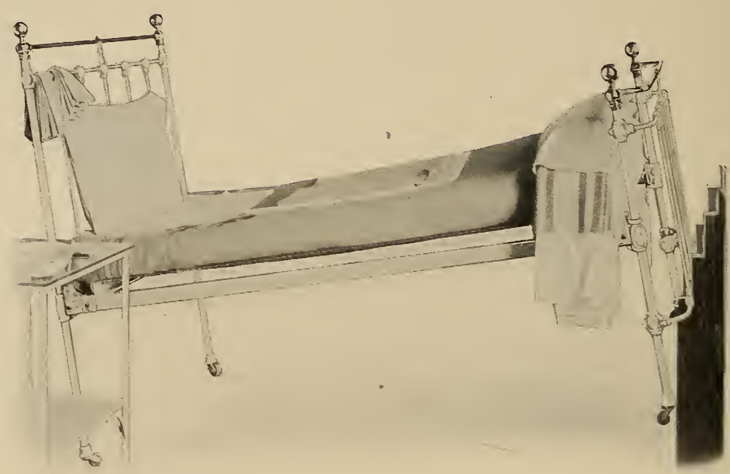

ILLUSTRATION XXXVI

Shock Bed.—Note the simple construction of the elevator. The bed covers are turned back to show the draw sheet and hot-water bottles. Observe the towels at the head of the bed for such emergencies as vomiting, etc.

position suggested, all unnecessary noise avoided, and excitement reduced to a minimum. If conscious, and aimlessly tossing in bed, the administration of morphin hypodermatically is indicated. Dissolution being imminent, employ cardiac massage and use artificial means to stimulate the respiration. (See lecture on "Anesthesia," section "Accidents.")

Nurse's Duties.—

(1) Immediately notify the surgeon.

(2) If the patient is in the Fowler position following an operation, lower the head and elevate the foot of the bed to an angle of about 30°.

(3) If an accident case accompanied with great suffering, administer a small dose of morphin hypodermatically to block the pain, and place in a similar position.

(4) Apply artificial heat.

(5) Support the circulation by mechanical means.

(6) If transfusion or intravenous infusion is to be employed prepare the sites and sterilize the necessary instruments.

(7) Arrange personal toilet and assist surgeon in carrying out step six.

(8) Whichever method is employed, keep the exposed blood-vessels moistened with warm saline solution during the entire process.

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LECTURE XIII

HEMORRHAGE

By the term hemorrhage is meant *the loss of a large amount of blood from the vessels.* I shall limit this condition to a break in the vessel-wall, the result of trauma or operative measures, and not include other causes which do not concern you as surgical nurses; except to mention that peculiar condition known as hemophilia, which is "a tendency that certain individuals possess to bleed on the slightest provocation" (Rudolph Matas, M. D.), the cause of which idiosyncrasy is unknown.

Classification.—Depending on the kind of vessel from which the escape of blood takes place, hemorrhage is divided into

(1) Arterial.

(2) Venous.

(3) Capillary or parenchymatous.

Arterial Hemorrhage.—When the hemorrhage is from an artery the color of the blood is bright red and the flow, as a rule, pulsating and active.

Venous Hemorrhage.—The blood from the veins is dark, because it has eliminated its oxygen to the tissues. The current is passive or slow and there is no pulsation.

Capillary Hemorrhage.—This appears in the tissues without any definite vessel of origin being involved. There is no characteristic color, no pulsation; oozing is seen of an active or passive character.

Concealed Hemorrhage is where the bleeding is confined within the body, and *is not visible.*

Primary Hemorrhage.—By this term is understood the escape of blood immediately following the break in the vessel-wall.

Secondary Hemorrhage.—This term implies that a hemorrhage has supervened some time after an injury was received or operative interference.

Résumé of the Physiology of the Blood.—Besides the physiology which I have spoken about concerning certain constituents of the blood and the part

this fluid plays in *natural resistance,* it would be well to briefly state some of its other functions.

Blood is the chief factor in the physiology of vital processes. It is the medium through which oxygen is supplied to the tissues. It is the carrier of nutritive material derived from the food to the various parts of the economy. It is a factor in preserving body-temperature. The vasomotor center, the center of respiration, and other vital centers, depend on the *volume and character* of the blood-current for their functionating capacity. The amount of blood in the coronary arteries and in the cavities of the heart is the primary factor of cardiac physiology,—in short the blood is the primary requisite of life on which the various vital phenomena are dependent.

The *amount of blood* in the body is about one-fourteenth to one-twelfth of the body weight. Death is practically inevitable if one-half of the total amount in the economy is lost at one time, however, much larger quantities may be wasted if the hemorrhage is gradual,—that is to say, if the escape covers a long period of time,—say weeks, because Nature is afforded an opportunity in which to replenish the depleted system; for as Crile says, "the blood is, of all the tissues, most rapidly and completely repaired and regenerated."

The Pathology of Hemorrhage.—Death from hemorrhage *is not due to the loss of the elements of the blood, but to the insufficient amount to maintain blood-pressure.* The diminution of blood in the vessels causes an increased demand on the vasoconstrictor center in the medulla, whose function is *to regulate the caliber of the vessels in proportion to the amount of blood within. The greater and more sudden the hemorrhage, the greater and more severe will be the demand on this center to constrict the bore of the vessel to correspond to the diminished amount of blood. If the hemorrhage continues, the vasoconstrictor center ceases to functionate—becomes exhausted, because of the excessive demands made on it. Constriction of the caliber of the vessels is then lost, the entire vascular system relaxes, and blood-pressure drops; shock has been engrafted on an economy already depleted of blood!*

The existing phenomena therefore are:
(1) Actual loss of blood.
(2) Gradual decrease in blood-pressure.
(3) Vasomotor paresis.
(4) Constriction of caliber of vessels abolished.
(5) Blood-pressure reduced to a minimum.

Symptoms of Hemorrhage.—The *constitutional symptoms* of hemorrhage are very similar to those of shock. As I have stated before, when the bleed-

ing is of the *concealed variety* a differential diagnosis is sometimes impossible. (See lecture on "Shock.") On the other hand, hemorrhage other than the concealed class carries with it its own objective sign—*the presence of blood.*

Treatment.—The treatment of hemorrhage may be divided into two parts—

(1) The local means employed to arrest the flow.

(2) The general measures utilized to offset the deleterious effects on the economy.

The Local Means Employed to Arrest the Flow.—*The first essential in the control of hemorrhage is the ligation of the vessel.* This cannot always be accomplished because the injury may have been received in such a location of the body or under such unfavorable conditions as to preclude an immediate ligation, and to necessitate the transferring of the patient to more suitable surroundings to accomplish the necessary surgical interference. Under such circumstances reliance must be placed on other means than ligation of the vessel.

Posture.—This becomes an expedient in assisting to control the escape of blood. *Elevation of a bleeding area tends to lessen the force and amount of the arterial current, and at the same time favors the return of blood to the heart.* It makes no difference what part of the body is thus elevated, this same rule holds true. If the pelvis is the location from which the hemorrhage is occurring the "head-down" position (45°) will lessen the leak, and *possibly* check the flow, depending of course on the size of the injured vessel. If the escape of blood is from an extremity the raising of such a member to a perpendicular with the body will assist in retarding the escape; however, bleeding from an arm or leg can be controlled by better mechanical means, as will be described later. In *hemorrhages* from any portion of the head, neck, or throat, the same rule applies as to elevation, but it cannot be carried to the same extent as in other portions of the body, because in doing so such an anemic (bloodless) condition of the vital centers may be produced as to cause a complete cessation of their function. This leads to another statement: in cases of impending dissolution from the loss of blood, the elevation of the pelvis ("head-down") 30° to 45° is indicated; *the object being to conserve the remainder of the blood around the cerebral and medullary centers* in an attempt to prolong life until remedial efforts can be administered.

Pressure.—This may be applied either *directly* on the bleeding part, or *indirectly* over the course of the vessel, either of which is an efficient means of controlling hemorrhage until ligation can be accomplished.

Direct Pressure.—This is accomplished in a variety of ways; the simplest form is by pressure of the hand at the site of injury; other forms of pressure are obtained by compresses, tampons, instruments, and ligatures.

Indirect Pressure is obtained by utilizing the Esmarch tourniquet, which is a strong rubber band of various lengths, and can be purchased anywhere; or an equally efficient substitute may be made by utilizing rubber-tubing. (See illustration XXXVII.) The tourniquet is adjusted at a point above the

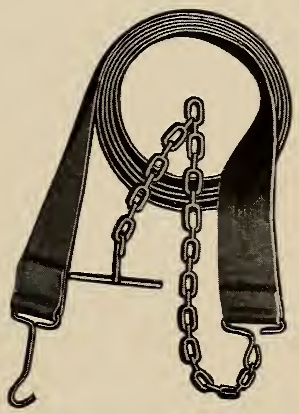

Illustration XXXVII
Esmarch Tourniquet

bleeding area, and its application made by stretching with each turn of the circle.*

In emergency cases, removed from hospital service, where the usual rubber tourniquet is not at hand, clothesline, fountain-syringe tubing, suspenders, or even a handkerchief may be tied around the bleeding member, and the necessary amount of tension made by passing a lever beneath the improvised tourniquet and twisting it,—the Spanish windlass.

Heat.—This is utilized frequently to check capillary hemorrhage, by wringing sponges out of very hot water and applying them to the bleeding area, being assisted by direct pressure. The employment of *boiling water* as recommended for this purpose should not be seriously considered, as this may cause sloughing of the tissues.

* In cases of hemorrhage of forearm or leg, the tourniquet must be applied above the elbow or knee.

These expedients are only temporary for the control of hemorrhage, *the desideratum is the direct ligation of the bleeding vessel,* and this should be done *whenever possible.*

The General Measures Utilized to Offset the Deleterious Effects on the Economy.—The conservation of the remaining portion of the blood in the body is accomplished by depleting or "milking" the blood from the extremities toward the trunk and maintaining it there for a limited period of time, the steps of which are as follows:

Method One.—

(1) Elevate the member.

(2) Stroke the member from the digits (fingers or toes) toward the trunk until the part becomes pale in comparison with its fellows.

(3) Apply a tourniquet around the limb as close to the trunk as possible. All four members may be thus treated.

A more efficient way is:

Method Two.—

(1) Elevate the member.

(2) Apply a rubber bandage to the limb with spiral turns from the distal extremities toward the body, thus *forcing the blood ahead of the bandage into the large abdominal vessels.*

(3) Apply a tourniquet close to the trunk to prevent the return of blood.

(4) Remove the bandage.

The first method is applicable to emergency cases occurring outside of hospital service.

Compensation for Loss of Blood.—The most efficient way to accomplish this is by means of *transfusion.* The difficulty however of obtaining the blood of another makes it an expedient which cannot always be utilized. *Intravenous infusion of normal saline combined with solution adrenalin chlorid* becomes then the second choice. The advantages of this solution are the absence of complicated mechanism, and the facility with which it may be administered. The disadvantages however are the following:

(1) Its stimulating action is of short duration.

(2) If a sufficiently large amount is infused it reduces the specific gravity of the blood, and hence permits the transudation of the fluid through the coats of the vessels.

Administration of Water by the Mouth.—In severe cases of hemorrhage thirst is insatiable,—the patient continually demands fluids. The drinking of water does little or no good, as absorption is at the minimum and the

sufferer will sooner or later eject the contents of the stomach. This is mentioned because you should not be deceived with the idea that restoration of the body-fluids is taking place through this medium.

Rest.—It is hardly necessary for one to allude to this important factor. Every exertion on the part of the patient increases the outflow of the blood. It is therefore your duty to maintain the sufferer in complete rest.

Conserving Body-temperature.—This must be accomplished by means of artificial heat, using warm-water bottles, etc.

Medicinal Agents.—If the patient is conscious, suffering pain, and aimlessly tossing, a small dose of morphin hypodermatically is indicated. Besides quieting the patient, its effects on the circulation are not to be underestimated.

Employment of nitroglycerin, a vasodilator especially of the veins, is positively harmful because these vessels are already proportionately too large for the amount of blood in the economy.

Alcoholic and other stimulants are contraindicated while hemorrhage is occurring.—What good can be obtained by stimulating a heart to force more blood from a leaking vessel? The condition is changed, however, when the flow is stopped; then *stimulation is indicated,* the various forms of alcohol should be administered by the mouth, and stimulating rectal enemata given of brandy and strong coffee in saline solution, possibly strychnin hypodermatically.

Local Astringents.—The long list of styptics (drugs used locally for the arresting of hemorrhage) which are advised in text-books on materia medica have little if any effect. *Solution adrenalin chlorid* (1:1000) applied to the bleeding area is efficient in venous oozing, but has no value in arterial hemorrhage.

Monsel's Solution of Iron (liq. ferri subsulphatis) is the best of this class of drugs,—it *certainly will arrest venous hemorrhage,* but the slough it produces in the tissues prohibits its employment *except as a last resort.* One of the most devastating hemorrhages I ever witnessed followed an operation for tonsilectomy. The patient was practically exsanguinated. Every known method of arresting the flow had been tried, pressure made with gauze moistened in solution adrenalin chlorid, the pillars of the tonsils were sewed together, purse-string sutures were taken around the base of the tonsil, pressure on the carotids, elevation of the head was carried to an extent to produce anemia of the cerebrum with its accompanying collapse,—all with negative results. As a last resort Monsel's solution of iron was

applied with *instantaneous relief.* A necrotic slough followed as usual, lasting two weeks.

Nurse's Duties.—

(1) If after operative procedures *in the abdomen* the pulse becomes weaker and faster, with a corresponding drop in temperature, *whether there is discernible hemorrhage or not,* summon the surgeon.

(2) If hemorrhage is discovered following an operation on an extremity, or on a superficial area of the body, arrest the same with a tourniquet, or remove outer dressings and make pressure on the bleeding area until surgical assistance is obtained.

(3) If compression is impossible, elevate the bleeding area *whenever practical,* thus placing the part in a position opposed to gravity.

(4) If a fatality seems imminent, *irrespective of the location of the hemorrhage* elevate the foot of the bed 30° to 40° in an endeavor to maintain a blood-supply to the brain.

(5) Supply artificial heat to maintain body-temperature.

(6) Conserve all blood possible by milking extremities, and adjusting tourniquets close to the trunk.

(7) Prepare for transfusion or intravenous infusion of normal saline solution combined with adrenalin chlorid. (See lecture on "Transfusion—Infusion.")

(8) Quiet nervous restlessness by hypodermatic injections of morphin sulphate gr. 1/8 to gr. 1/4 *in the absence of proper authority.*

(9) Hemorrhage being checked, stimulation is indicated, and orders will be given for the same.

The above rules are quite as applicable to emergency cases as to accidents following postoperative interference.

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LECTURE XIV

WOUNDS, CONTUSIONS, AND ABRASIONS

By the term wound is understood *a violent solution of the continuity of the soft tissues of the body.* Inasmuch as a wound may be produced in different ways, give various appearances to the eye, and cause dissimilar pathologic conditions, they are designated accordingly:

Classification.—

(1) Incised.

(2) Contused.

(3) Lacerated.

(4) Punctured or stab wounds.

(5) Gunshot wounds.

(6) Open surgical wounds.

(1) *An Incised Wound* is one made *by a sharp instrument,* as a knife or the edge of broken glass. The lips of such a wound *are clean cut, permitting of smooth approximation.*

(2) *A Contused Wound* is one in which the edges *are contused, crushed, and ragged. The injury extends to the surrounding tissues.* It is produced by blows from clubs, falling timber, or stones, hence the edges *cannot be smoothly coaptated.* The adjoining tissues *are partially devitalized* because the *blood-vessels* supplying the parts *have been damaged.*

(3) *A Lacerated Wound* is one in which *large surfaces have been mangled and tissues torn apart*—such results as you would expect to see from the *claws of an animal or coming in contact with the gears of machinery, or railroad accidents.* The margins of such a wound *are irregular —indeed tissue is often wanting to fill in the gap.* This wound is of greater severity than the contused, simply because the surrounding area has been more damaged.

(4) *Punctured or Stab Wounds* have been very aptly described as having but "slight opening in the integument, with comparatively great depth of penetration."—(CRILE.) Such injuries as are caused by sharp-pointed

knives, bayonets, or nails. These wounds are dangerous, inasmuch as they cannot be examined carefully nor thoroughly cleansed.

(5) *A Gunshot Wound,* according to Senn, is one caused by any missile projected by an explosive agent. The characteristics of such a wound of course vary with the projectile. The entrance of a gunshot wound produced by a lead bullet is smaller than the exit. With the modern steel-jacketed bullet the two wounds are generally of equal size. Occasionally, however, the wound of exit may be so diminutive as to be *overlooked.* Another peculiarity of a gunshot wound *produced by a lead bullet of slow velocity,* is that it carries dirt and fragments within the tissues, while the modern high-speed jacketed bullet is much less liable to do so. The latter appears to sterilize the tract it has made.

(6) *An Open Surgical Wound.*—Occasionally when a large amount of tissue has been removed by the surgeon and the edges cannot be coaptated, or it is presumed that infection is present, the wound is left open to afford better drainage. It may be termed *an open surgical wound,* because it cannot be identified with any of the foregoing. You will note that it is not an incised wound because the edges are not, or cannot be coaptated; it cannot be classified in the contused variety, since there is no contusion of the tissues; nor is it mangled, to come under the head of lacerated wound.

You must not confound a *poisoned* with an *infected* wound,—*the former is the result of the entrance of some chemical poison, such as the stings of insects, reptiles, etc., while an infected wound is one in which bacteria have gained a foothold.*

A contusion is really a *subcutaneous* wound,—*the skin itself is not broken, but the tissues beneath have suffered injury.* Occasionally a vessel of considerable size is wounded, or several minor vessels, and an extravasation of the blood occurs, forming a clot beneath the tissue, which is called a *hematoma.*

An abrasion is simply a denuded surface.

Repair of Wounds.—The principles involved in wound repair are the same in all classes, the only practical difference being the *amount of such repairative process.* It has been customary, in order to bring before the mind's eye certain factors dealing with wound healing, to describe three processes, viz., healing by the *first, second,* or *third intention.*

Healing by the First Intention, or Primary Union.—This can only take place when the surfaces of the wound can be nicely coaptated; it is therefore in the incised variety of injury that this form of healing generally occurs.

Process of Repair.—Immediately after a wound takes place there will be more or less blood poured into the cavity. Whatever care or means is made to remove this, there will still remain some microscopical clots.

The first step in the process of repair is a dilatation of the blood-vessels supplying the part. The blood-current is retarded, and *an exudation of serum, fibrin, and red and white blood-corpuscles takes place.* If the surfaces of the wound are nicely coaptated *agglutination* occurs as a result of the elements which have escaped from the vessels. The leukocytes dispose of the microscopical clots which were left, assist in making away with the dead-tissue cells, and with the aid of the opsonins derived from the blood-serum devour any pathogenic bacteria which may be present. Sooner or later *epithelial and connective-tissue cells proliferate* on the raw surfaces,—oval in shape at first, not partaking of the characteristics of the parent cell. Sprouting from the capillaries, newly formed blood-vessels appear on the surface, forming loops between the new epithelial and connective-tissue cells. If the wound were pulled apart, so as to permit an inspection of its depths, a granular appearance would be observed, *due to the proliferation of cells and the newly formed blood-vessels.* This is known as *"granulation tissue."* The connective-tissue cells soon begin to *change their shape;* they become more elongated until they dovetail or interlace with each other. *A process of contraction begins.* The majority of the newly formed *blood-vessels are obliterated* by this process of pressure. The contraction continues until *a dense pale tissue is formed. The denser this tissue the less will be its vascularity, because the greater will be the obliteration of the vessels.* This is termed a *cicatrix or scar tissue.* Healing by the first intention is accomplished, which requires a period of from seven to ten days. This result can only be obtained when the tissues have suffered the smallest amount of trauma and the wound edges are coaptated, and when infection has not occurred or the tissues have not been devitalized by the abuse of strong antiseptics. Healing by the first intention, therefore, implies that the wound *surfaces have been coaptated, and joined together by the minimum amount of scar tissue.*

Healing by the Second Intention—Secondary Union, or Healing by Granulation.—This is a similar process to the one just described. The difference is chiefly in the quantity of the material required for repair. When a certain amount of tissue has been lost the *surface and edges of the wound cannot be coaptated,* so that it is necessary for some "filling in" to take place with newly organized material.

Process of Repair.—The local blood-vessels which have been injured *at once dilate, the blood-current is slowed, transudation of fibrin, serum,*

leukocytes, and red blood-corpuscles takes place from the vessels, forming a serofibrinous exudate on the raw surface. This film of exudation not only serves the purpose of protection, but also forms a groundwork for the future processes which are about to take place. The *leukocytes* which have appeared on the field are *making away with debris, devouring pathogenic bacteria and raising the natural resistance of the part, and are performing the function of phagocytosis,* as explained in the lecture on "Infection."

Following this process (which may be aptly termed Nature's preparatory methods) the *epithelial and connective-tissue cells begin to proliferate. Newly formed blood-vessels from the veins and capillaries appear.* The epithelium "juts out" from the skin edges toward the center of the wounded area. The connective-tissue elements form layer upon layer; they cover the wounded surface and are surrounded by loops of newly made blood-vessels, giving a granular appearance,—the so-called "granulation tissue" which appears about the fourth day. These cells which were oval at first, now become elongated, interlace with each other, and a process of contraction begins which obliterates the newly formed blood-vessels interwoven in their midst. As this process of contraction continues the vascularity diminishes, but the new-formed tissue becomes denser. Scar tissue is thus formed. The constant tendency to contract which this new tissue possesses develops the many deformities incident to burns. If the *area to be covered is large* the epithelium springing from the edges of the skin is only capable of covering a limited zone around the free margins of the wound, leaving the center bare. The connective-tissue elements in this nude area continue to proliferate *above the surface of the skin,* and are called *prolific granulations or "proud flesh."* In many instances it becomes necessary under these conditions to supply epithelium to the central portion. This is accomplished by curetting the excessive granulations and *transplating thin films of skin from other portions of the body,—skin-grafting.* These small islands of transplanted skin form nuclei from which epithelium spreads.

Healing by the Third Intention.—After the appearance of granulation tissue, *efforts are made to approximate the edges of the wound* by the use of adhesive plaster or other mechanical means, preferably after curetting the superficial granulations. This can only be done where small surfaces are wounded, *the object being to lessen the amount of scar tissues on the skin surface,* and hasten the process of healing.

Recapitulation.—I have considered it advisable, although it be repetition, to give a synopsis of the various steps in the process of wound repair, a

careful analysis of which will demonstrate the striking similarity of all varieties.

(1) Dilatation of blood-vessels, slowing of blood-current.

(2) Transudation of fibrin, serum, and red and white blood-corpuscles.

(3) Process of phagocytosis occurs, that is the leukocytes with the aid of the blood-serum are disposing of dead tissue and pathogenic bacteria.

(4) Agglutination of wound surfaces (only in healing by first intention).

(5) Proliferation of oval-shaped connective-tissue and epithelial cells.

(6) Development of newly formed blood-vessels.

(7) Formation of granulation tissue, the result of intermingling of the newly formed tissue cells and capillaries.

(8) Tissue cells change their shape, become elongated, and interlace with each other.

(9) A process of contraction begins, obliterating the newly formed blood-vessels.

(10) Contraction produces density of newly formed tissue.

(11) A cicatrix or scar tissue is developed.

General Consideration of Wounds.—*Hemorrhage.*—This depends on several factors, chiefly among which is the vascularity of the part injured. The richer the blood-supply and the larger the arteries, the greater, of course, will be the loss of blood. The *kind* of *wound* decides to some extent the amount of bleeding. The incised variety as a rule will produce a greater hemorrhage than the contused and lacerated, because the clean-cut edges of the former allow a freer escape of blood than the crushed ends of the latter; however, secondary hemorrhage is much more common in contused and lacerated wounds because of the slough which takes place later. Hemorrhage is an important factor in the production of shock following these injuries.

The physical condition of the patient is a factor that determines the amount of hemorrhage to some extent. The plethoric (full-blooded) individual will certainly be more apt to suffer severe hemorrhage than the pale anemic subject. The patient with hardened arteries bleeds easier and freer than one whose vessels are soft and more collapsible.

Since hemorrhage plays an important part in the production of shock, it should be therefore the first consideration in the treatment of wounds. During an operation the control of bleeding vessels is under the supervision of the operator, but in accidental wounds or in postoperative cases, it occasionally falls to the lot of a nurse to meet the exigency. The healing of a

wound to a great extent depends upon the thoroughness of hemostasis, so it becomes necessary to pay strict attention to this.

Pain.—This will depend of course on the part injured, the greater the nerve supply the more pronounced will be this symptom. The hyperesthetic (oversensitive) patient will suffer physically and psychically more than the phlegmatic. The more severe the pain, the longer its continuance; the more nerve tissue injured and the greater the psychic effect, the more liable is the patient to shock. In the treatment of accidental wounds the object should be to minimize the amount of pain by the use of morphin hypodermatically, which will in no way interfere with the administration of an anesthetic, if such becomes necessary later.

Ecchymosis ("Black and Blue").—In nearly all classes of wounds excepting possibly the incised, there will be more or less extravasation of blood which discolors the surrounding area—the so called *"black and blue,"* or technically, *ecchymosis.* The more superficial this extravasated blood, the sooner will ecchymosis make its appearance; the deeper the extravasation, the more delayed will be this symptom. It is for this latter reason that ecchymosis is occasionally not apparent for several days after an accident. The presence of this symptom indicates the rupture of vessels beneath the skin to a greater or less depth, and to some extent is an indication of the amount of injury the part received. Such extravasated blood is removed by the action of the leukocytes, and possibly to some extent by direct absorption.

Rest—General and Local.—The patient has suffered not only a local injury, but an impression has been made on the nervous system, an impression that is proportionate to the injury, and susceptibility of temperament. In all severe wounds the patient should be put to bed as soon as possible. *Local rest* is indicated because it favors a more rapid healing, and limits infection. If such a complication occurs the part should be splinted if practical so as to prohibit muscular action.

Cleanliness.—It has been said the final result of wounds, and even life itself, depends upon the thoroughness of *first-aid treatment.* For this reason there is no excuse for not being surgically clean in the treatment of wounds *whether surgical or accidental.* Great stress is laid on the preparation of the field for operation, while carelessness is frequently witnessed in the cleansing of an accidental wound. Deviation from the strict rules of asepsis is not warranted because a wound has been received under septic conditions—in fact, the reverse is true. Such wounds require greater care to prevent infection. The part is laboring under great disadvantages. I may mention in this connection, as first shown by Crile, that the oil-

besmeared hands of machinists and railroad men when injured are really more aseptic and require less care in their surgical preparation than the hands of workmen soiled with the dust and dirt of the street.

Treatment of Wounds.—In order to give a clear idea of the duties of a nurse in the treatment of wounds I shall divide these injuries into two classes—(1) Aseptic and (2) Infected Wounds.

(1) *Aseptic Wounds.*—There is really no such condition as a wound free from pathogenic bacteria, but wounds that are made during an operation with everything sterile connected with the technic should be considered aseptic. It is the aim of the surgeon to make incisions in such a manner that the edges of the wound will nicely coaptate (incised variety) *so as to obtain healing by the first intention*—that is with as little scar tissue as possible. In fact, I should say an incised wound *however caused* (especially where cosmetic effects are necessary) should be treated as aseptic, until infection proves it to the contrary. Occasionally, however, where large areas of tissue have to be removed, it is impossible to coaptate the edges of the wound because of the excessive tension this will produce, *so that a raw surface is left to heal by the second intention,—the open surgical wound.*

Aseptic Incised Wounds—Principles Involved.—

(1) Complete control of hemorrhage.

(2) Thorough cleansing of the wound of all blood-clots.

(3) Coaptation of the wound by sutures.

(4) Introduction of drain, if wound is deep and fear is entertained of capillary oozing.

(5) Application of sterile dressings, held in place by bandages.

(6) Rest.

Aseptic Open Surgical Wounds—Principles Involved.—

(1) Complete control of hemorrhage.

(2) Thorough cleansing of the wound of all blood-clots.

(3) Protect the raw surface by several layers of sterile gauze.

(4) Approximate the edges by the use of adhesive strips placed over the gauze to relieve tension of the wound.

(5) Complete the dressing with cotton-gauze pads held in place with a bandage.

Nurse's Duties.—

(1) Frequent inspection of the outer dressings for the first twenty-four hours to ascertain if there is any secondary or postoperative hemorrhage.

(2) If such is the case immediately notify surgeon.

(3) Rise in temperature and pulse rate occurring from the fourth to the seventh day is indicative of infection. Call surgeon's attention to the same.

Change of Dressings—Aseptic Incised Wounds.—The drain, if any has been used, is removed in twenty-four or forty-eight hours, following which no change in dressing will be necessary, until convalescence is established and the sutures are removed after having served their purpose.

Aseptic Open Wounds.—A change of dressings is advisable about the sixth or seventh day to ascertain the condition of the granulation tissue. If this is progressing favorably, the dressings need only be renewed every fourth or fifth day.

Necessary Equipment.—

(1) Irrigator filled with sterile water.

(2) Hydrogen dioxid in a sterile glass.

(3) Kelly pad (sterilized).

(4) Tray containing one pair of scissors and dissecting forceps (sterilized).

(5) Ward dressing outfit, adhesive plaster, rubber tissue.

(6) Dry sterile gloves (dry gloves are easier adjusted).

Steps of Technic—Nurse's Duties.—

(1) Nurse prepares her surgical toilet (omit gloves).

(2) Remove outer dressings from patient excepting the gauze adherent to the wounded surface.

(3) Arrange sterile towels around the field to prevent contamination from bedclothing, etc.

(4) Place Kelly pad under the field and arrange for drainage.

(5) Assume gloves and begin the dressing.

(6) Moisten the adherent gauze with hydrogen dioxid to soften and permeate the crusts.

(7) Irrigate with sterile water until the adherent gauze is detached. *No force is permissible in the removal of a dressing as in this way granulation tissue is damaged and an opportunity afforded for infection. The presence of a healthy granulation tissue indicates that Nature has thrown a barrier between the deep tissues and external infection. This barrier is therefore to be preserved intact.*

(8) Apply sterile dressings to the wound, held in place with adhesive straps, followed if necessary by the use of a bandage.

Complications.—

(1) If on inspection the granulations appear pale and anemic the surgeon will order some stimulating application such as balsam of Peru, or carbolic acid lightly mopped over the surface and immediately neutralized with alcohol.

(2) If the epithelium has been unable to cover the denuded area and prolific granulations ("proud flesh") are present, the surgeon will curette

the surface and perform skin-grafting. In which case cover the field with perforated oiled silk or strips of this material used shingle-fashion. This affords a better protective for the outgrowth of the epithelium than gauze, in fact, whether skin-grafting is resorted to or not, rubber tissue forms the best protection after the establishment of healthy granulations.

(3) If the wound be of the open surgical variety and shows a tendency to gap, or its edges pull apart, after the sterile-gauze dressing is applied, an endeavor should be made to approximate the edges and relieve tension by the use of adhesive straps.

(4) If between the fourth and seventh day in an incised wound, there is a rise in temperature and pulse rate, associated with pain in the region of the wound, inspection is at once indicated. If infection is present remove stitches to permit of drainage and treat the injury like any other infected wound. . . . . .

Removal of Coaptating Stitches.—When sutures have served the purpose for which they were used it is necessary to remove them (generally in about eight or ten days), especially if they are non-absorbable. I desire to impress on you that it is just as essential to carry out an aseptic technic in this connection as though a more important operation was to be performed. Frequently infection occurs at this time from carelessness.

Necessary Equipment.—

(1) 1 pair of sharp-pointed scissors and dissecting forceps (sterilized).
(2) Sterile glass of hydrogen dioxid.
(3) Alcohol or Harrington's solution.
(4) Sterile towels.
(5) Dressings.
(6) Wipe sponges.
(7) Gloves.
(8) Adhesive plaster.

Steps of Technic.—Steps 1, 2, 3, 4, and 5 are the same as have been given when describing the technic of "Change of Dressings."

(6) Saturate a piece of gauze with alcohol or Harrington's solution and lay over the stitches for one or two minutes.

(7) With the aid of dissecting forceps pull one side of the stitch upward, cut the same as close to the skin as possible, then remove the suture.

(8) Protect the stitch holes by applying sterile-gauze dressings, held in place with adhesive straps.

Infected Wounds.—Infection has been defined thus: "When bacteria sufficient in number or virulence to overcome the natural resistance have gained entrance into the economy it is infected." I also told you that the symptoms

of this condition were heat, redness, swelling, pain, and pus—the culmination of local infection—so that when on inspection these signs are present in a wound, you know infection has occurred.

The results of Wound Infection are—

(1) Greater destruction of tissue.

(2) Longer period of time required for repair.

(3) A possibility of general infection due to absorption of bacteria.

Infected wounds do not heal by the first intention. The process of repair is consummated by replacement with granulation tissue: the second, or third intention. *Contused or lacerated wounds* should always be considered infected. The surrounding area has been more or less devitalized. They are always of accidental origin occurring among environments which are not conducive to asepsis.

Infected Wounds—Principles Involved.—

(1) Free drainage.

(2) Arrest of further bacterial invasion by the strictest antiseptic technic.

(3) Rest.

Drainage.—If the wound is of the *incised variety,* and its surfaces have been coaptated with sutures in the hopes that healing by the first intention would be obtained, these should at once be removed to allow the free escape of pus, and the cavity carefully washed with a *very mild* warm antiseptic solution such as mercuric 1:5000, carbolic acid 1 per cent., or tincture of iodin 1 per cent. Large volumes of these solutions are needed (quantity not strength) to mechanically remove necrosis and such bacteria as lay on the surface, besides helping to revitalize such tissues as have not already broken down. Sterile water is just as efficient, *perhaps more so.* Normal saline solution should not be used as *an irrigation in infected wounds,* because partaking *to some extent* of the characteristics of blood-serum, it forms with the semidevitalized tissues a culture-medium for the propagation of bacteria. Under no circumstances are strong antiseptics indicated. They produce albuminous deposits when in contact with tissue and favor the development of necrosis, hence cause the further increase of microörganisms and the formation of pus. *In contused or lacerated wounds* where blood-vessels have been destroyed, and consequently the tissues devitalized from lack of nutrition, the ragged edges and slough should be carefully dissected away without injuring the area whose vascularity is still maintained. Pockets and cavities should be sought for, and followed with such irrigations as have been described.

Arrest Further Bacterial Invasion.—This can be accomplished in two ways—

(a) By dry dressings changed daily preceded by warm irrigations.

(b) By moist dressings changed several times a day.

Dry Dressings.—Iodoform gauze is generally chosen for this purpose. It should be placed *loosely* in the cavity (if an incised wound) or on the surface of an infected area (if lacerated or contused), *never tightly applied.* The discharges of the wound coming in contact with the iodoform liberates the iodin. Absorption of the drug takes place not in such quantities as to produce further irritation, but sufficient to prohibit bacterial growth. It is an antiseptic, not a disinfectant. Sterile dressings are applied over this medicated gauze and the part put at *rest,* which factor will be dwelt on at more length later. *Until infection is overcome and granulation tissue established* these dressings are changed daily, preceded by large volumes of hot sterile water or very mild antiseptic solutions to facilitate their removal and preclude injury to the developing granulations. *Granulation tissue having developed, a change of dressings is not needed oftener than every four or five days, as in aseptic wounds.*

Moist Dressings.—Plain gauze moistened with hot antiseptic solutions (mercuric 1:5000 or carbolic acid 1 per cent.) are placed on the infected area covered with oiled silk which prevents evaporation, and over this are laid generous quantities of sterile dressings. These are changed every two or three hours. The objection to moist dressings is, that if continued for any length of time the tissues become macerated, which certainly favors bacterial growth. As soon as the acute signs of infection have abated and granulations developed, dry-gauze dressings should be substituted, which need not be changed oftener than every four or five days. As a rule the pus which is present prevents the gauze adhering to the wound. It is therefore easily removed, but should it be adhered the use of hydrogen dioxid followed by copious irrigations is indicated. No traction is permissible. *When granulation tissue appears it is evidence that bacterial invasion has ceased.* If the wound originally was of the *incised variety* attempts should be at once made to approximate the edges so as to favor union with as little scar tissue as possible. If a *contused or lacerated wound* sterile dressings are applied, over which adhesive straps are placed to prevent excessive gaping of the wound and to relieve tension.

Rest.—This I consider the most essential step in the treatment of any wound, and especially so in the infected variety. Nearly any kind of clean dressing will have salutary effects providing the part is given *perfect local rest.* On the other hand, the most carefully chosen dressing will have no effect toward restoration of the part unless provision is made for rest. I

would much prefer a splint and a bandage without dressings, than plenty of dressings and no splint. In all steps that have been given you in the care of wounds *rest* stands as the most prominent factor in the treatment of such injuries. It is utilized not only to allow the physiologic conditions that are going on to progress undisturbed, but it is employed to obliterate muscular action, which is the motor to the lymphatic current and which must be reduced in the presence of a local infection to prevent general sepsis taking place.

Bier's Hyperemic Treatment.—This as I have told you in one of my early lectures is simply an artificial means of procuring for the affected area an additional amount of blood, thereby increasing the number of leukocytes and causing a greater outpouring of serum,—a method of reinforcement of the natural resisting powers of the body. In infected wounds this method is employed alone or in conjunction with the treatment I have outlined.

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LECTURE XV

FRACTURES

By the term fracture is understood *a broken bone or cartilage.* It should be borne in mind that the entire bone need not be entirely separated into fragments for the injury to be classified under this head. In the so-called green-stick fracture some fibers of the osseous structure are undoubtedly separated, but the majority are only bent; then under gunshot fractures are included perforations of the bone made by the bullet.

There are as many varieties of fractures as there are authors on this subject; it will not be necessary for you as nurses to study the numerous classifications, so I will only give you a description of the commonest forms.

Classification.—*A simple fracture* is one in which there is a break in the continuity of the bone with little or no damage to the soft tissue.

A compound fracture is one where there is a wound through the soft tissues producing an *atmospheric communication with the point of fracture.*

A simple fracture may become compound. By rough handling at the time of injury the broken ends may be forced through the soft tissues, or a similar condition can take place by an imperfectly treated fracture in which the fragments are not coaptated but meet angularly, causing pressure on the soft tissues, and followed by a slough. Compound fractures are exceedingly dangerous injuries.

Speaking in the early part of my lectures I referred to some tissues which had a high resisting power, while others had a very slight resistance to infections; at that time I mentioned that the marrow of bones had a very low resisting index. It is for this reason infection is so liable to occur in compound fractures, and in their treatment every precaution must be used to prevent this complication by employing the acme of surgical antisepsis.

A comminuted fracture is one where the bone is broken into several pieces with a *communication between the fragments.*

A multiple fracture is one where the bone is broken in several portions, *but there is no communication between them.*

An impacted fracture is one in which the broken ends of the bone have been driven into each other (dovetailed).

The term green-stick fracture conveys to the intelligence that the bone is bent in a manner similar to what you would expect when a force is applied to a green stick,—some of the fibers of the bone are broken, but the majority are only bent. This fracture is seen chiefly in children.

A gunshot fracture is a fracture produced by some missile projected by an explosive, hence you can easily understand these are all of the *compound* variety and need special care.

A complicated fracture is one in which severe damage has been wrought to the surrounding structures, muscles may be lacerated, nerves and blood-vessels injured, or even a dislocation added to a fracture in its vicinity.

Besides this classification, fractures are also designated according to the *direction* the separation takes between the fragments: An *oblique* fracture indicates that the injury extends obliquely across the bone. A *transverse fracture* separates the fragments at right angles to the shaft of the bone. *Spiral fractures* are those in which the line of separation takes a curved or spiral course. Without further comment you can easily grasp the nomenclature accorded by various authors to this class of injuries.

Causes of Fractures.—The primary factor in the production of fractures is *violence,* applied either *directly* to the part or *indirectly;* as an example of the former may be cited a blow from a club on the forearm fracturing the ulna or radius, or one falling on the point of the shoulder and breaking the surgical neck of the humerus. The well-known fracture of the clavicle, the result of falling on the extended arm, the force being transmitted through the member, is an example of *indirect force* producing fracture. *The secondary causes* of fractures are various. *Old age* with its degenerative processes and the changes that occur in the constituents of the bone whereby the osseous structure becomes more brittle, is a predisposing cause. The *seasons of the year* have an influence in this class of injuries. The ice-covered streets and sidewalks in winter are certainly likely to cause falls, to which may be added the greater tonicity or tension of the muscular system during this season. By this you will understand the muscles are held in a more rigid condition. Sudden muscular contraction, in bones *made fragile by disease,* will produce fractures without any external violence. This form of injury is known as a *pathologic fracture.*

Signs of Fractures.—Besides the symptoms of pain, swelling, and possibly ecchymosis, which are common to other injuries, there are certain other signs which are more distinctive in the diagnosis of fractures, although the presence of blood occasionally becomes an important diagnostic sign in frac-

tures of the skull,—as an example, the presence of blood oozing from the ear in fractures of the base of the brain (middle fossa).

(1) *Loss of Function.*—In most cases of fracture the injured member becomes immediately helpless because the bone being broken, the muscles do not have stationary points from which to contract. However, in *impacted fractures* where the fragments are driven into each other, and in certain gunshot fractures, the muscles still retain their function because the continuity of the bone is not entirely destroyed, so that occasionally the injured member may be used for a short time.

(2) *Preternatural Mobility.*—By this is understood, *motion occurring in a location where motion should not be present;* as an example, if on examining the shaft of a long bone mobility is discovered, a conclusion would at once be formed that a separation of its continuity had occurred because of the abnormal location for motion. When preternatural mobility is noted it is prima facie evidence of a fracture. However, this sign is wanting in many cases,—as in green-stick, impacted, and some cases of gunshot fractures.

(3) *Crepitus.—By this term is meant a grating of the two fragments when brought in contact with each other.* This sign is indisputable evidence of a fracture. Like the former symptom it is not always possible to obtain it, as in fractures at the base of the skull, in impacted fractures, and where muscular and other soft tissues are interposed between the broken ends, this valuable sign is wanting. In certain diseased conditions of joints a crepitus is heard and felt, but to the experienced this form of crepitus (false crepitus) is vastly different to the *true* crepitus of a fracture. The two forms of crepitus must always be remembered.

(4) *Deformity.*—This is a symptom of other injuries besides those referred to. Taken, however, in connection with the signs already mentioned, it becomes an important item. You must not think by the term deformity is necessarily understood some angularity in the shaft or some plainly visible abnormality in the shape of a bone; these are present at times, but a deformity may exist *so slight* that it becomes necessary to carefully measure the injured member and compare such measurements with the opposite side. As an example, in fracture of the head of the femur, it is always necessary to measure the distance from the anterior superior spine of the ilium to the tip of the internal malleolus *of both limbs* to ascertain whether the injured limb is *shorter* than its fellow. If such is the case there is *deformity,* but yet so slight as not to be discernible to the unaided eye.

(5) *Radiograph.*—In spite of all care it is occasionally impossible to obtain the usual signs of fracture when this injury is present. In such cases the X-ray in the hands of an experienced radiographer should be relied on.

This is especially true of fractures of the pelvis, base of the skull, and in some cases of impacted fracture, where the most experienced will occasionally be in error without its use.

Repair of Fractures.—I shall not attempt to describe in detail the several changes which take place in the uniting of bony fragments, but shall only give the most important steps in the healing process of these injuries.

Covering the external surface of bones is a thick fibrous tissue called the *periosteum,* the function of which is to afford nutrition to the bony structure it clothes. If the bone is denuded of this covering necrosis, or death of the bone, frequently follows, because the blood-vessels which permeate the periosteum and finally enter the bone substance for its nutrition, are destroyed. On the inner surface of bones, or in other words, surrounding the marrow cavity, is a delicate fibrous membrane called the *endosteum* which is richly supplied with blood-vessels. *It is chiefly through the medium of these two tissues that the repair of fractures is accomplished, possibly aided by certain elements from the surrounding soft tissues.* When a bone is broken the *periosteum, endosteum,* and more or less of *the neighboring structures* are torn or lacerated. The consequence is that a certain amount of blood escapes around the fracture, forming a clot. This is simply a mechanical loss of blood and in nowise (as far as known) aids in the process of repair, but is immediately removed by the action of the leukocytes. This debris being cleared away, the active steps in new bone formation begin. Cells derived from the torn periosteum covering the external surface of the fragments begin to proliferate or multiply. The injured endosteum from the inner surface of the bone likewise proliferates its cells. In the meanwhile small blood-vessels are formed which permeate this newly developed tissue and afford it nutrition. The connective-tissue cells from the soft parts which were injured around the fracture also begin to multiply. Thus three different cells are developing around the fractured bone for its repair: externally, those derived from the periosteum and the connective-tissue cells from the soft parts; within the bone, those developed from the proliferating cells from the endosteum—all of which are nourished by newly developed blood-vessels. Thus you will appreciate that Nature is repairing the injured bone from within and without. This newly formed tissue is termed *temporary callus*—temporary because the greater portion of it will be absorbed. These new deposits are also known as *external* or *ensheathing callus* and *central* or *medullary callus,* according to the location where they are formed; the terms are sufficiently descriptive to need no further explanation. The next step in the maturing of this callus (for it is yet in a soft formation) is the deposit of lime salts between the cells, which sooner or later partake of the charac-

teristics of cartilage, and eventually this is transformed into bone. Or cells having bony characteristics may develop from the first. The former however is the general rule. The process of complete bone formation requires from five to seven weeks. These little deposits of cartilage or bone extend *from one end of the broken fragment to the other.* Externally around the bone a ferrule-like callus (ensheathing callus) is formed; while within there is developed a reinforcement or plug (central callus). The *ensheathing callus,* while it is more or less a deformity at first because of the superabundance of new material thrown out, is eventually absorbed to a greater or less extent. If the bones are nicely coaptated only that portion of the callus which cements the broken ends remains. This is then termed *permanent callus.* If a large gap of bone has to be filled in, or if the fragments are not nicely adjusted, Nature does not absorb the superabundance of callus and deformity always exists. The medullary or central callus is at times absorbed. Thus an analysis of bone repair will demonstrate that the parent bone takes no part in the process of its own repair.

Complications Following Fractures.—The complications which may follow these injuries are numerous, yet in proportion to the number of fractures I do not think they are seen as frequently as one might expect.

Injuries of the Blood-vessels.—These are caused by the sharp ends of the fragments cutting one or more of their coats, either at the time of injury or through careless handling of the injured member by those giving first aid, or during manipulations necessary for the adjustment of the fracture, and finally this same complication may arise from improperly adjusted fragments where great deformity exists. You can easily understand if the main artery supplying a limb is irreparably lacerated the circulation may be entirely cut off, or the nutrition seriously interfered with. In either case a severe hemorrhage will occur. It is self-evident that even though the blood-vessels are not lacerated a great deformity existing in the vicinity of large blood-vessels can exercise such pressure as to interfere with the circulation. Occasionally an injury to the vessel is so great as to necessitate an amputation of a limb either immediately after the fracture or subsequently. The circulation, too, can be impaired and in fact entirely obliterated by improperly applied splints and poor bandaging. Severe swelling occurring after a fracture deserves careful consideration. It may be due to concealed hemorrhage or an obstructed venous circulation. *For the first few days after a fracture of an extremity the nurse should pay special attention to the circulation of the part, the digits* (fingers or toes) *serving as an index.*

Injuries of the Nerves.—What is true of blood-vessels is also true of the nerves supplying a fractured member. They are equally liable to be torn, and

suffer from displaced fragments or deformity caused by faulty adjustment, with the result that certain areas or entire members may be paralyzed.

Delayed Union—Nonunion—Vicious Union.—When through lack of proper treatment the bones are not immobilized; or when the soft tissues are thrust between the fragments at the time of injury; or when the nutrient vessels of the bone are destroyed; or when the proper adjustment of the fragments has not been made; or when the injured one is suffering from impoverished health, as degenerative changes in the blood-vessels, syphilis, etc.—*delayed union,* or even *nonunion,* is the consequence. After union has taken place between the broken fragments of bone and there remains great deformity and impaired function of the member, it is termed *vicious union.* These abnormalities, whether or not they be due to a lack of care on the part of the surgeon, and frequently they are not, are considered by the laity a sufficient justification for malpractice suits.

The Skin and Superficial Tissues—Decubitus (Bed-sore).—In certain fractures, such as those occurring about the pelvis, around the hip-joint and vertebral column, in fact in *any diseased condition* where it becomes necessary for the patient to be kept in one position for any length of time, the pressure exercised by the weight of the body interferes with the blood supply to the underlying part to the extent that a slough occurs, leaving an ulcer, which is known as *decubitus or bed-sore.* This is most frequently seen *in the aged, or those suffering from degenerative changes and whose circulation at best is impaired.* The involuntary escape of urine, the wetting of the bedclothing, the lack of a proper toilet after defecation, the escape of the contents of sand bags when employed, and bread crumbs and other extraneous matter in the bed frequently produce sufficient irritation to be the starting-point of such an ulcer. This complication may develop in spite of all the cleanliness which may be exercised, and all the care which can be bestowed on the patient. Bed-sores may be the cause of death. The patient instead of succumbing to the original disease *dies from a general infection superinduced* by this complication. This is mentioned advisedly with the hopes of impressing on you the care which should be exercised to prevent the formation of these ulcers and the aseptic treatment necessary after their development. While the most common location for bed-sores is on the superficial tissues over the sacrum and trochanters of the femur, you must not think that these are the only localities for their formation. They are commonly seen on the heel, back of the head, and elbow, in fact wherever a bony prominence is undergoing pressure from the weight of the body.

Treatment of Decubitus.—Remove body-pressure by the use of an inflated rubber ring, give careful attention to thorough cleanliness; bathe and massage the part under pressure several times daily with alcohol or possibly a

solution of alcohol and alum, or the glycerol of tannin, in an endeavor to harden or toughen the tissues.

After the ulcer has formed, stimulating dressings are indicated, such as the balsam of Peru; or the daily or every-other-day application of nitrate of silver, the surgeon of course dictating the treatment as he sees fit. Your duty will be to prevent if possible the development of such ulcers, and if in spite of all care they form, to endeavor to prevent infection by the most careful asepsis.

Infection.—This occurs chiefly in the compound variety of fractures and becomes a very grave complication. The septic material may have gained entrance at the time of the injury or infection may have occurred later through careless methods of dressing the injury. I can think of no accident which requires more thorough asepsis than the treatment of compound fractures.

Shock.—This is seen chiefly in severe fractures of the cranium, thorax, vertebrae, and pelvis.

Pneumonia.—This complication may be the direct result of the injury, as in fractures of the ribs (*traumatic pneumonia*), or it may supervene later, especially in debilitated or old subjects who from the nature of their injuries are forced to remain in a recumbent position. In these cases the enfeebled circulation gravitates to the posterior portion of the lung and produces what is known as *hypostatic pneumonia.*

The well-trained surgical nurse should be acquainted with these complications, not that she will be called on to treat them, *but that she will be in a position to recognize them the instant they occur, and call the attending surgeon's notice to the same.* She should be educated along these lines so that the daily memoranda will carefully detail such abnormalities in the course of the treatment as will be of interest to the surgeon, and a benefit to her patient.

The Principles of Treatment of Fractures.—*First Aid.*—From what you have learned concerning fractures you will readily appreciate that the treatment of these injuries begins immediately the accident is received. The bystander who renders first aid either performs good service or adds further injury by the rough handling of the broken member. Unnecessary manipulations at this time are wrong. If the patient is to be moved to his or her residence or hospital, some temporary means should be employed to immobilize the broken bone so as to prevent the sharp fragments from lacerating blood-vessels, nerves, and other soft tissues. It is generally good policy to remove all clothing from around the injury, this should be accomplished by carefully cutting away the garment so as not to jar or cause further pain or injury, as would ensue if attempts were made to remove the

clothing otherwise. This being accomplished a better opportunity is afforded to judge the extent of the injury, to ascertain if hemorrhage is present and endeavor to check it, to note whether the fragments are about to transfix the soft tissues and produce a compound from a simple fracture; or, if such a complication has occurred, it facilitates the application of some antiseptic solution if any be at hand. In any case further mangling of the soft parts can be prevented by having the clothing removed. *First-aid* treatment is simply a matter of individual ingenuity; the attendant who can improvise, is the man or the woman of the hour: no set rules can be given—simply suggestions made.

Fractures of the Lower Extremities.—Immobilize the member by binding the same to a light board, or other substitute, at hand—anything of sufficient length to brace the fractured member. Under no circumstance should the patient attempt to walk. Should the accident have occurred in a locality removed from ambulance service, improvise a litter from a wide board or even a door.

Fractures of the Upper Extremities and Trunk—The Arm.—Bind the member to the trunk, place the forearm in a sling.

Forearm and Hand.—Utilize a strip of wood, such as a shingle, portion of a cigar-box, or even heavy card board, bind the member to the same and suspend in a sling.

The Ribs.—Nothing can be done in this region to afford much relief, because a bandage sufficiently tight around the thorax to abolish muscular movement on the injured side will interfere with respiration—nevertheless it is the most appropriate treatment.

Fracture of the Clavicle.—Support the fractured bone by utilizing a sling; adjust the same so that the shoulder on the injured side is higher than its fellow; bind the arm to the trunk.

The Lower Jaw.—Use the upper jaw as the immobilizing agent; hold in place with a bandage made from a handkerchief carried from under the jaw over the head and tied.

Fracture of the Vertebrae.—Place on a litter, remove to residence or hospital; avoid all unnecessary handling of the patient.

The Pelvis.—If the symptoms suggest a fracture of this region, encircle the bones with an improvised girdle snugly applied.

Preparation of the Patient.—A fracture being an emergency, preparatory treatment is limited. The nurse's duties will vary according to the destination of the patient; if it is the hospital, the emergency operating-room will be the scene for the final treatment of the injury; if taken home, prepara-

tions will have to be made for the patient's reception. But in any case, the following steps must be carried out:

(1) Remove clothing and adjust nightgown.

(2) Conserve the patient's resisting power by the proper adjustment of covers. (There is more or less shock with every fracture.)

(3) Carefully remove first-aid dressings.

If a *simple fracture* thoroughly cleanse and shave the part; dry thoroughly.

If a *compound fracture* the greatest antiseptic care must be taken. The wound is supposed to be infected, therefore large volumes of mild, warm antiseptic solutions should be employed to cleanse the wound and the surrounding area, not in a haphazard way, but in the following manner:

(a) A protective gauze pad moistened in an antiseptic solution should be laid over the wound to *prevent any further infection* during the necessary ablution of the injured member.

(b) Cleanse the area in the proximity of the injury according to the rules given for the "Preparation of Patient for Operation."

(c) Remove protective pad.

(d) Thoroughly irrigate the wound with large volumes of mild, warm antiseptic solutions.

Anesthesia.—An anesthetic is used in highly nervous individuals, where the patient is suffering severe pain or in cases where muscular contraction interferes with the necessary manipulation; and in compound fractures, where it has been decided to wire the ends of the bone, or in such cases where operative interference other than the adjustment of the fragments is necessary. In such cases it may be prudent to lavage the stomach previous to the administration of the anesthetic, especially if ether or chloroform is to be used. This procedure prevents the unsightly vomiting of the patient, shortens the time of the anesthetic, and lessens the danger of the drug. It is best accomplished by having the patient drink large volumes of water before the tube is inserted.

Dressings Employed in Fractures.—The objects to be accomplished in dressing a fracture are the following:

(1) To adjust the fragments in as near a normal position as possible. This is known as *the reduction of a fracture.*

(2) To keep the same in position by perfect immobilization. This is accomplished by means of *splints, which are simply braces used to retain the fragments of bone.* They are made from various materials, such as light metal, wood, papier-maché, plaster of Paris, and silicate of soda. There are numerous kinds of splints sold on the market supposed to be adapted for

the various fractures; but the more you come in contact with practical surgeons, the more you will observe that these ready-made splints are not frequently used, the surgeon improvising for the individual case. A good splint should be light and possess fair tensile strength,—wood of a proper thickness has these qualifications. Several varieties of this material are found on the market cut in various lengths and widths, such as *bass and yucca wood.* A splint to be of any practical purpose should be of sufficient length to form a stable brace, and wide enough to prevent the constriction of the member when the bandage is applied; in other words, a trifle wider than the injured member. To prevent undue pressure it should be thoroughly padded with cotton held in place by a roller bandage. On account of its elasticity, the common cotton wadding found on the market is preferable to the absorbent material for this purpose. In every hospital there should be a special room assigned in which are kept the various dressings necessary for the treatment of fractures. A fracture is an emergency which requires immediate attention. It does not add to the dignity of any institution to force the interns and nurses to search every floor for such articles as are needed, yet this is not an uncommon occurrence. After a fracture appliance has been removed from a patient it should be immediately returned to the room designed for such accessories, which should be as nicely appointed and kept as any other apartment,—but how seldom is this seen.

Articles to be Kept in Stock.—

(1) Bass or yucca wood. Poplar boards of various widths and lengths, one-eighth to one-fourth inch in thickness.

(2) Wire netting, one-fourth-inch mesh.

(3) Plaster-of-Paris bandages of various widths.

(4) Strips of sheet metal three-fourths inch wide for reinforcement of plaster casts when necessary.

(5) Rolls of ordinary cotton wadding.

(6) Gauze roller bandages, various widths.

(7) Adhesive plaster.

(8) Extension apparatus.

(9) Sand bags of different lengths, five to six inches in diameter.

With these materials the practical surgeon will be enabled to treat the majority of fractures.

Reduction of Fractures.—I have endeavored to outline the preparation of the patient before the surgeon attempts reduction. I have tried to give you an adequate idea of the materials used in the dressing of fractures. *The reduction of the fragments is of course the duty of the surgeon.* If the fracture be of the simple variety the dressings I have mentioned will be

sufficient for the surgeon's needs. If, however, the fracture be *compound*, besides the necessary retaining splints, such surgical materials and instruments will be required as in other operations, and preparations should be made accordingly.

Some of the More Common Modifications Used in the Treatment of Fractures—Change of Splints.—

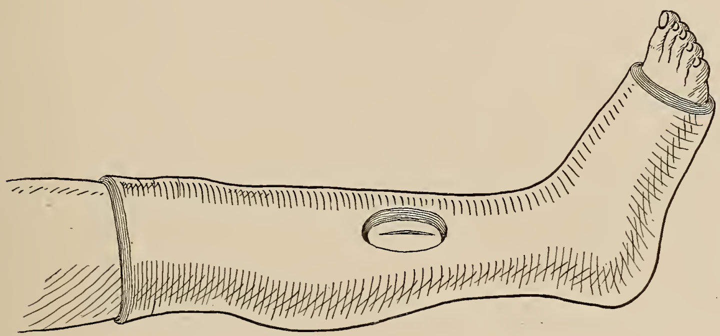

ILLUSTRATION XXXVIII

A Plaster-of-Paris Cast.—Showing a fenester or window cut in the same, through which the wound may be dressed without removing the immobilizing splint.

(1) Frequently after the acute symptoms have subsided the ordinary wooden or metallic splint is removed and a *plaster-of-Paris cast* substituted, the object being to afford the patient more security from injury, as well as to obviate the necessity of having to readjust the bandages. When the fracture is of the compound variety, after the plaster-of-Paris cast has been molded to the part, a window (fenester) is cut around the point of fracture so that dressings may be applied to the wound and still have the member immobilized. (See lecture on "Preparation and Sterilization of Gowns, Sponges, Dressings," etc., section "Plaster-of-Paris Bandages"; Also illustration XXXVIII.)

Extension.—

(2) In fractures of the lower extremity, especially of the femur, where contraction of the muscles occurs, producing deformity which cannot be overcome by the ordinary splints, the surgeon resorts to *extension*.

Buck's Extension Apparatus.—This is made and applied in the following manner—

(a) Shave, cleanse, and thoroughly dry the limb.

(b) Apply a strip of adhesive plaster three inches wide to both sides of the member, beginning a little below the fracture and extending the same four to six inches below the sole of the foot, thus forming a loop.

ILLUSTRATION XXXIX

Buck's Extension Apparatus.—Note the following points: that the foot of the bed is elevated to produce counter extension, that the weight does not touch the floor, that the sole of the patient's foot does not come in contact with the footboard, that a sand bag is utilized to assist in immobilization and prevent rotation.

(c) Obtain a piece of wood three inches square and one-fourth inch thick; make a hole in the center of this one-fourth inch in diameter. The wood is then placed on the inner side of the plaster loop to which it adheres and reinforces. Cut a hole in the plaster corresponding to the hole in the wood.

(d) Protect the prominent bones of the ankle-joint (internal and external malleoli) by surrounding the same with gauze so as to prevent the plaster from irritating.

(e) Encircle the limb with a well-applied bandage; this makes the plaster adhere snugly to the member.

(f) Pass one end of a cord (sash cord is generally used) through the perforation in the plaster loop and its reinforcement of wood; knot the same. The other end is carried over a pulley which has been attached to the foot of the bed. Apply the necessary weight to this end of the cord.

(g) Elevate the foot of the bed four to six inches, thus obtaining counter extension.

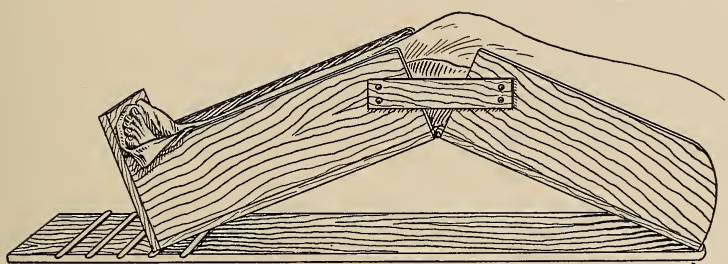

Illustration XL

An improvised Double-inclined Plane Splint

(h) Place sand bags on either side of the injured member to afford immobilization as well as to prevent eversion of the foot in fractures of the neck of the femur. (See illustration XXXIX.)

The nurse should be careful to keep the sole of the foot from coming in contact with the footboard and prevent the weight from touching the floor, either of which would defeat the purpose of the extension. She should also keep the sand bags closely applied to the limb to overcome outward rotation and maintain immobilization.

(3) *Double-inclined Plane.*—Another common modification for the ordinary straight splint is the double-inclined plane, the mechanical construction of which will be appreciated by referring to the illustration. This apparatus is allowed to rest on the bed or may be suspended in a swing. It is used in fractures of the shaft of the femur and of the leg. (See illustration XL.)

(4) *Fracture Box.*—In fractures of the leg accompanied with great swelling, deformity, and damage to the soft tissues, a fracture box is frequently employed for the first few days until the swelling has subsided, after

which the permanent dressings are applied. The advantages of this form of temporary splint are—

(a) Inspection can be made of the injured member without disturbing it.

(b) Constriction from the use of bandages is obviated.

(c) Topical applications are easier applied, such as ice, evaporating lotions, etc.

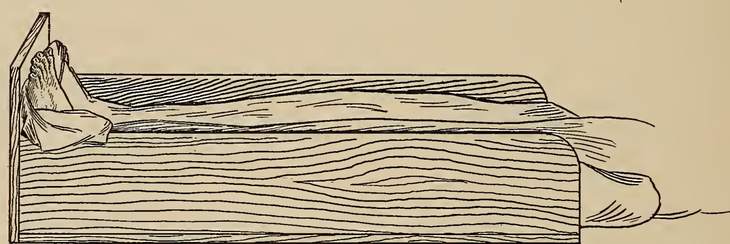

ILLUSTRATION XLI

Ordinary Fracture Box.—Observe the profuse loose dressings within, which prevent undue pressure.

Illustration XLI gives a good idea of its construction. The bottom and sides of the box should be generously padded with cotton wadding, and pressure removed from the heel of the foot by making a small ring of cotton wadding, wrapped with a bandage for this portion of the member to rest in, the so called *"bird's nest."*

(5) *Ambulatory Treatment of Fractures.*—This manner of treating fractures of the lower extremity is especially adapted to the aged or enfeebled patient, whose health will be further reduced if forced to remain in bed for any length of time. These are the subjects prone to develop hypostatic pneumonia, bed-sores, etc., to obviate which some form of fixation apparatus is designed for the individual case, which permits the patient to move about after the acute symptoms have subsided. Some surgeons advocate this plan of treatment in a wider range of cases than the limitation that is here given.

Fracture Bed.—In fractures of the vertebrae, pelvis, or lower extremities is is necessary that the patient be placed on a firm bed free from any sagging which would tend to produce deformity and prevent perfect immobilization. In such cases a *fracture bed* is constructed, which consists of

boards placed between the mattress and springs. The mattress should be of good quality, not soft, and preferably made of hair or felt.

Cradle.—In injuries of the lower extremities it is desirable that the pressure of the bedclothing be kept from the injured member. This is

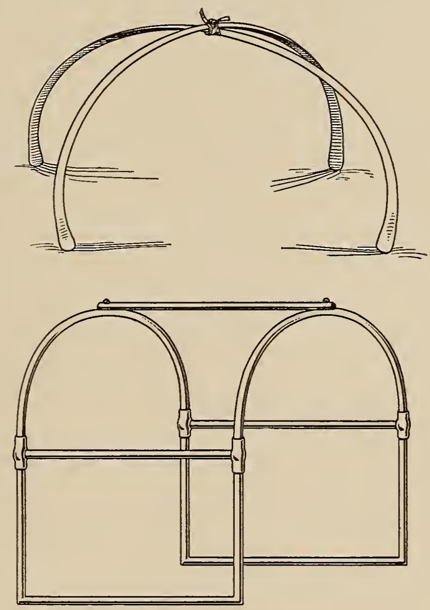

Illustration XLII

Cradle.—The lower illustration is the form used in hospitals, while the upper picture gives an adequate idea of an extemporized cradle for use in private practice.

obviated by using what is known as a *cradle,* numerous varieties of which are found on the market; they are made of light steel. An extemporaneous apparatus may be made from barrel-hoops placed crosswise and tied in the center, as seen in illustration XLII.

The After-treatment and Care of Fractures.—In fractures of the upper extremity the patient is usually allowed the freedom of going and coming

as he pleases after the fracture has been reduced. This is the ideal in all fractures wherever occurring, because the sudden transition from an active life to one of inactivity leaves its impression more or less on the patient. The general health suffers, and especially is this true of the aged who cannot tolerate confinement. The organs of excretion become sluggish; the appetite depreciates and insomnia is more or less present.

In fractures of the lower extremities, pelvis, vertebrae, or cranium, it is compulsory to confine the patient to bed. In these cases it becomes necessary to use every endeavor to prevent such complications as may develop because of the recumbent position of the patient, such as bed-sores, hypostatic pneumonia, bronchitis, etc. The patient therefore should be allowed to sit up as soon as possible. Alcohol baths and massage should be administered, special attention being given to such portions of the body as are under pressure. The Bradford frame is useful for cases of this kind. It consists of a rectangular frame constructed of steel tubing over which is stretched two pieces of stout canvas, leaving an opening at the site of the buttocks. It is raised by means of pulleys. By this method the sacrum and other prominent portions of the pelvis which are liable to bed-sores can be massaged daily, and a thorough toilet made after each defecation. The danger also of displacing the fragments when moving the patient to use the bedpan is reduced to a minimum.

In fractures of the pelvis or of the head of the femur it frequently will be necessary to resort to catheterization because of the inability of the patient to urinate. In these cases a careful watch should be made for the presence of blood which is suggestive of an injured bladder.

If blood is discovered in the feces a notation should be made on the chart, and the surgeon's attention called to it. *If the thorax* has been the seat of accident bloody expectoration is indicative of an injury to the lung.

In all cases of fractures of the extremities special attention should be paid to the fingers or toes for the first three or four days to *ascertain the condition of the circulation.* Edema or swelling of these parts may indicate an obstructed circulation—an obstruction due to laceration of the veins, pressure from misplaced bones, or poorly applied dressings.

Diet.—A soft diet is indicated for the first two or three days.

Passive Motion.—At a variable time, generally two to four weeks, depending on the location of the fracture and the individual ideas of the surgeon, careful and slight movement is made of the injured member, gradually increasing the radius of motion from day to day; the object being to prevent

any unnecessary loss of function of the member. This is termed *passive motion.*

Nurse's Duties.—These have been sufficiently explained in the text of the lecture to make a summary unnecessary.

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LECTURE XVI

DISLOCATIONS AND SPRAINS

An Articulation or Joint.—When two or more segments of the skeleton, whether osseous or cartilaginous, are connected together it is termed a *joint or articulation.* It is not necessary for a wide range, or any motion to be present, to come within this definition; as in the articulations between the vertebrae only slight movement is present. Again, some joints are *immovable,* as those in the adult cranium; nevertheless the junction of these bones is considered an articulation. As a general proposition I think it may be stated that the more highly organized the joint, the greater range of motion it possesses, and vice versa. You can easily understand there are other tissues which enter into the construction of an articulation besides the bony structures. Among these may be mentioned *cartilage.* There are several varieties of this tissue, each having certain functions. The cartilaginous discs between the vertebrae, not only unite the vertebral bodies, but act more or less as shock absorbers. The semicircular plates of cartilage on the head of the tibia form concavities for the reception of the convex lower extremity of the femur.

Ligaments.—These serve as binding media to lace or connect the articular end of one bone to the other and are composed of fibrous tissue, which is strong, tough, flexible, and practically inelastic, permitting of a wide range of motion without stretching unless under great strain.

The Synovial Membrane.—This is a thin serous tissue which extends from the *circumference* of one articular surface to that of the other, thus forming a closed sac or cavity. It lines the inner surface of the ligaments which connect the bones together, and clothes any tendon which passes through this cavity. *This serous tissue does not cover the articular ends of the bone.* It is supplied with the same blood-vessels and nerves which nourish and innervate the joint. Its function is to lubricate the joint, to supply "joint water," as it is vulgarly termed. This membrane is very susceptible to infection, and easily becomes inflamed when injured.

Tendons.—These do not enter into the formation of a joint and are only mentioned in connection with an articulation, because they are the motors

which functionate the joint. The tendon of a muscle is the distal portion which eventually is attached to the osseous structure. Frequently in inflammation of a joint, the tendon also becomes inflamed.

Dislocations are *persistent* displacements of two articular surfaces. A *sprain* is a *temporary separation.* In other words when a joint is *dislocated* the articular ends are so displaced that they cannot readjust themselves and *persist* until artificial aid is afforded; while in sprains the disarrangement of the articular surfaces readjust themselves without assistance,—hence only a *temporary separation.*

Classification of Dislocations.—The classification of these injuries follows to some extent that of fractures.

(1) A *complete dislocation* is one in which the articular surfaces are entirely separated from each other.

(2) *An incomplete dislocation* (also termed partial dislocation or subluxation) is where the articular ends of the bones *are not completely separated.*

(3) A *compound dislocation* is one where there is an atmospheric communication with the joint,—there is a wound through the soft tissues.

(4) A *simple dislocation,* as the name implies, is where there is a separation of the articular surfaces with little damage to the surrounding parts.

(5) A *complicated dislocation* is the reverse of the last described variety. Injuries have occurred to the soft tissues; vessels or nerves may be torn, or one of the bones forming the joint may be fractured.

(6) A *congenital dislocation* is one that occurs in utero, and does not include those which happen during childbirth.

(7) An *old* or *ancient dislocation* is one of long standing, in which inflammatory changes have taken place in the soft tissues and the articular surfaces themselves have been more or less obliterated by fibrous deposits.

Besides these classes some authorities have attempted an *anatomical division* of these injuries, aiming to describe the dislocation according to the new position which one articular end of the bone has assumed. As an example: a *subglenoid dislocation* is one where the articular head of the humerus lays below the socket (glenoid cavity). *A dislocation of the femur on the dorsum of the ilium* indicates that the head of the femur is resting on the posterior portion of that bone.

Causes of Dislocations.—*Exciting Causes.*—

(1) *Violence.*—This may be the result of *direct* or *indirect* force. As an example of the former, a sudden wrench of the ankle dislocating that articulation. Indirect force travels through the length of the bone or mem-

ber producing a dislocation of some remote joint—as a dislocation of the shoulder as the result of a fall on the outstretched hand.

(2) *Muscular Action.*—A dislocation of the lower jaw occurring during the act of yawning, or the displacement of the head of the humerus in the effort of throwing a ball, are examples of injuries caused by muscular action. There is every reason to believe that muscular action plays an important role in all varieties of dislocations even where violence is the exciting cause. Again in certain diseased conditions of the joints where the articular surfaces are eroded the constant contraction of the muscles causes separation of the articular surfaces, producing what is known as a *pathologic dislocation.*

Predisposing Causes.—

(1) *Destructive Joint Disease,* as has already been mentioned in connection with muscular action.

(2) *Age.*—This form of injury is more prevalent in middle age.

(3) *Sex.*—The male with the usual increased muscular development is more predisposed.

(4) The various *occupations* which require great muscular effort.

(5) The *anatomical mechanism* of the joint bears an important relation to dislocations. The greater the range of mobility in an articulation, the more predisposed is such a joint to dislocation, hence the ball-and-socket joints are the articulations generally involved.

Signs of Dislocations.—

(1) *Pain* is present immediately. *Swelling* ensues rapidly. *Ecchymosis* is a delayed sign.

(2) *Preternatural Immobility.*—The motion of the joint is limited,—some actions may still be retained, but the majority are abolished.

(3) *Loss of Contour of the Joint—Deformity.*—In comparing the injured articulation with its fellow of the opposite side a change in form is at once seen, possibly the rotundity of the well member gives way to a flat or angular condition of the injured one.

(4) The *presence* of the *articular end* of the bone in an *abnormal position,* or its *absence* from the *normal location.* As an example, the finding of the head of the humerus in the axilla (arm pit) and the absence of it from the glenoid cavity (socket).

(5) The radiograph. By this means the diagnosis is confirmed.

Differentiation between Fractures and Dislocations.—

Fractures.—

Preternatural mobility.

Crepitus present.

Deformity returns after reduction unless artificial means are used to maintain the fragments.

Dislocations.—

Preternatural immobility.

Crepitus absent.

Deformity disappears and remains absent after reduction.

In complicated dislocations the signs of fracture and dislocation may both be present. The radiograph demonstrates the actual condition in any case.

Changes Occurring in the Joint after Dislocation (Pathology).— I shall confine my remarks to changes produced about the joint, the result of dislocations of traumatic (violent) origin, and not include those occurring as a sequence of diseased joints (pathologic dislocations).

When an articulation has been dislocated as the result of violence, the ligaments are torn or lacerated; the synovial membrane ruptured; cartilages possibly displaced to a greater or less extent, and the periosteum stripped from the bone where articular ends have been fractured. As a rule the nerves and blood-vessels do not suffer, although these are occasionally implicated. When a vessel of any size is damaged, a severe hemorrhage occurs around the joint, causing great swelling; while an injury to the nerve produces a neuritis which persists for some time after the accident and occasionally, as in dislocations of the shoulder, a partial paralysis may develop.

In ancient dislocations the inflammatory action which ensues at the time of injury agglutinates the soft parts in abnormal positions. The articular surfaces are filled with new deposits. Reduction therefore is impossible unless surgical procedures are resorted to. Occasionally in an unreduced dislocation the bone forms a socket for itself in a new location and a fairly useful joint is the result.

Ankylosis.—When an inflammatory action occurs in a joint, the result of infection or the sequence of violence, the results of such inflammation are capable of destroying the mobility of the articulation to a greater or less extent by the formation of exudates. This condition is termed *ankylosis.* Constitutional diseases such as rheumatism can also produce such deformities.

Treatment of Dislocations.—*First Aid.*—A dislocation should be reduced immediately, before swelling ensues and muscular contraction complicates

the reduction. The clothing should be cut away from the injured member. Under no circumstances should attempts be made to change the position which the member assumes, as this is the most comfortable to the patient. Unnecessary manipulations may further lacerate the soft tissues around the joint; in fact, rough handling of a dislocated member frequently causes as much or more injury than the primary accident. Support the member by such improvised means as are at hand. Remove to house or hospital. Summon the surgeon. In the interval apply cold applications to prevent undue swelling.

If a *compound dislocation,* the wound should be immediately protected in an endeavor to prevent infection entering this portal and producing inflammatory changes in the joint.

After first aid has been rendered there are three indications to be met—

(1) Reduction.

(2) Immobilization.

(3) Endeavor to prevent inflammation.

Reduction.—It is the surgeon's province of course to reduce dislocations. All necessary manipulations therefore will be made by him. As a general proposition it is not only easier for the surgeon, but safer for the patient, to *have an anesthetic administered.* Muscular rigidity is thus overcome, tension is relaxed, and the bones are easier manipulated and with less damage to the tissues. Dislocations are emergencies; the preparatory treatment of the patient before the administration of the anesthetic under such circumstances, has been suggested in the lecture on "Fractures."

Immobilization.—Bearing in mind the conditions present in dislocations, it will at once become apparent that immobilization is necessary to allow the repair of the soft tissues and absorption of any effusion or exudation which may develop around the joint. This is accomplished by splints properly applied.

Endeavor to Prevent Inflammation.—After reduction and immobilization have been accomplished the application of ice bags prevents swelling and effusion to a great extent, besides rendering comfort to the patient.

If the *dislocation* be of the *compound variety* surgical procedures are indicated. The necessary instruments and dressings should be provided for the surgeon, as in all probability counterincisions will be made to afford free drainage.

Treatment of Sprains.—As I have already stated, *sprains* are only a temporary separation of the articular surfaces, spontaneous reduction takes place, so that the indications for treatment will be *immobilization* and an *endeavor to prevent inflammation* by the use of refrigerant applications and

evaporating lotions. In other words, the treatment of sprains is similar to the treatment of dislocations after the latter have been reduced.

After-treatment of Dislocations and Sprains.—This is practically the same as the after-care of *fractures.* The invalidism of the patient is not as prolonged in this class of injuries; passive motion of the joint is begun earlier; the complications which arise in fractures are not apt to occur in dislocations excepting in the *compound variety.*

Nurse's Duties.—These have been sufficiently explained in the lecture to make a summary unnecessary.

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LECTURE XVII

BURNS AND SCALDS

These are *injuries caused by the action of heat,* although *the effects of caustics and acids, and the results of lightning or electricity,* are included under this head. This form of injury is classified as first-, second-, and third-degree burns, so as to give an intelligent description of each variety.

First-degree Burns.—These are characterized by a simple redness of the skin—erythema. This symptom continues for several days and is frequently followed by desquamation. Sunburn is a typical example of this injury. Simple as the ordinary cases of sunburn appear, you must not conclude that first-degree burns are inconsequential. If a large area of the skin-surface is involved, serious symptoms may develop and even fatalities ensue if two-thirds of the body-surface is involved. No deformity results from this degree of burn.

Symptoms and Course.—When a small surface is involved slight pain of a burning nature is present, and the constitutional symptoms are few if any. On the other hand *if large areas are affected* general disturbances will be manifested. The circulation shows signs of distress, the heart's action becomes weak, the extremities cold, and body-temperature drops below normal. The nervous system in proportion suffers, pain is intense. Shock occasionally develops. The digestive and urinary systems do not escape. Vomiting ensues, diarrhea or constipation may be present. The function of the kidneys may be reduced, the urine bloody and practically suppressed. You must therefore appreciate that in dealing with burns of the first degree covering large tracts of cutaneous nerves, efforts should be prompt, looking toward the relief of the patient.

Local Treatment.—Apply some demulcent to the affected part, such as the officinal oxid of zinc ointment freshly prepared, or boracic-acid ointment (4 per cent.), or carron oil (equal parts of lime water and linseed oil), over which place generous dressings of gauze held in position by roller bandages. Wet dressings may be substituted consisting of several layers of 20 by 24-mesh gauze moistened in normal salt solution or 0.50 per cent. carbolic-acid

solution, or a saturated solution boracic acid, or a solution of aluminum acetate, over which is placed rubber tissue and a suitable bandage applied.

Constitutional Treatment.—The first indication is the relief of pain by a suitable dose of morphin administered hypodermatically. If the heart's acton is getting faster and weaker, and symptoms of shock are becoming manifest, an infusion of normal saline solution with adrenalin is indicated. *Proctoclysis* is applicable in cases of acute nephritis complicating the accident. Digestive disturbances are met with appropriate remedies.

Second-degree Burns.—These are characterized by the formation of vesicles or blebs and are generally produced by boiling water or steam. The contents of these blebs is a clear serum at first which later may become gelatinous. Sloughing with scar formation does not develop in first- or second-degree burns; if, however, a second-degree burn becomes *infected,* such a condition may be produced.

Symptoms and Course.—These are practically the same as those of first-degree burns, *only more* intense. In severe forms the excessive stimulus made on the medullary centers is so great that shock is not uncommon. Congestions in the deeper viscera are not infrequent, the cerebrum also is occasionally involved. Constipation or diarrhea will be present. Ulcerations occur in the intestines and produce hemorrhages. Pneumonia may develop. Acute nephritis appears, due possibly to the extraction of serum during the formation of vesicles and to the disintegrative changes taking place in the blood. At times complete suppression of urine is noted.

Local Treatment.—The primary object in view in the local treatment of burns of the second degree is to prevent infection. An accident characterized with the formation of blebs on a surface which is not sterile has all the opportunities of becoming infected when the vesicles rupture spontaneously or are opened mechanically, by infectious material coming in contact with the denuded surface. *The highest degree of asepsis, therefore, must be maintained.*

The first-aid dressings cannot be accomplished as aseptically as subsequent ones, hence the *puncturing of the blebs should not be undertaken at that time.* Later, however, when the patient is relieved of pain and the stage of shock has passed, a methodical dressing of the injury should be undertaken. This is accomplished by thoroughly cleansing the surrounding area with *mild antiseptic solutions* of boracic acid (4 per cent.) or carbolic acid (0.50 per cent.), after which the blebs should be *punctured at their most dependent portion; but the covering of the vesicles allowed to remain intact.* All shreds and denuded tissue should be carefully excised. To complete the dressing a boracic-acid ointment or some similar demulcent is

applied, over which is laid several layers of gauze covered with generous amounts of cotton and held in place by suitable bandages, or the moist dressings as spoken of in first-degree burns may be used and covered with rubber tissue. If infection occurs moist dressings are preferable, and the subsequent treatment is the same as suggested for infected wounds. A frequent change of dressings is inadvisable except in infected cases.

The Constitutional Treatment.—This is the same as suggested in burns of the first degree. The relief of pain is imperative in an endeavor to prevent severe impressions being made on the centers in the medulla. Shock is relieved by the intravenous infusion of normal salt solution combined with adrenalin chlorid and such other steps as have been advised in the lecture on this subject. (See lecture on "Surgical Shock.") Acute nephritis, ulceration of the intestines, pneumonia, and other complications will be met with the appropriate treatment.

Third-degree Burns.—These are *characterized by actual charring or carbonization of the tissues to a greater or less degree.* The skin itself may be the only tissue involved, or the injury may be extended through all the tissues. The slough thus caused is termed an *eschar.*

Symptoms and Course.—The pain is generally not as severe as burns of the second degree, because the nerve endings have been destroyed, nevertheless this will depend to a great extent on the amount of surface involved and the part which is injured. The usual symptoms of burns are present, the weak heart, the lowered blood-pressure, and the nervous phenomena are very common. Congestions of the abdominal viscera associated with ulcerations especially of the duodenum are frequently seen, while cerebral and pulmonary complications are also found in this degree of burns. The urinary system suffers, not only because of the direct deleterious effects of the heat on the kidneys but because of the disintegrative changes in the blood and the extra demands suddenly made on these organs to eliminate large quantities of body toxins. Depending on the depth of the burn and the amount of sloughing which ensues, deformities of all kinds are the result.

Local Treatment.—Burns of the third degree should be treated similarly to infected wounds; warm, moist, mild, antiseptic dressings should be used and changed every three hours. As soon as possible (which will be about the sixth or seventh day) the eschar or slough should be carefully dissected from the healthy tissue, and the moist dressings continued until a healthy granulating surface is established, when dry dressings may be substituted. These are changed every three or four days, the same care being exercised not to damage the granulating surface while removing the adherent gauze. If the granulations appear pale and anemic, a 10-per cent.

balsam-of-Peru ointment may be used. (See lecture on "Wounds.") Skin-grafting should be resorted to early with the hope of lessening the deformity caused by scar tissue. Frequently operations are imperative to correct the many deformities that result from this class of burns. The caution which has been given you with regard to thorough asepsis in the care of second-degree burns applies with equal, or possibly greater force to this variety. The large sloughs of dead tissue which occur are accompanied with an equal amount of pus. These sloughs form a fertile culture-medium for the propagation of bacteria, the absorption of which means infection. In your preparation for dressings and personal toilet every step in the chain of asepsis must be carried out in detail.

Constitutional Treatment.—This is the same as has been suggested in burns of the second degree. Proctoclysis is especially indicated.

Causes of Death from Burns.—Fatal results may occur from the following:

(1) Shock.

(2) The disintegration of the elements of the blood, due to the extreme heat.

(3) Embolism.

(4) The loss of blood-serum.

(5) Acute nephritis, caused by the excretion of excessive toxic elements by the kidneys.

(6) Secondary hemorrhage.

(7) General infection.

(8) Complications of the deeper viscera, such as pneumonia.

Prognosis.—When one-half of the body-surface is burned a fatality may be expected. The extremes of age are especially susceptible to these injuries.

Nurse's Duties.—

(1) Summon the surgeon.

(2) If the patient is in great pain administer a proportionate dose of morphin hypodermatically.

(3) Put the patient at rest immediately; remove all clothing and substitute hospital nightgown.

(4) Prepare dressings.

(5) Prepare intravenous infusion of normal salt solution with adrenalin chlorid.

The first aid having been rendered the secondary duties of the nurse begin.

(1) Pay careful attention to the pulse and temperature.

(2) Note the character of the respirations. If inspiration be difficult it may be due to an acute inflammation of the glottis which demands immediate surgical attention. Examine the stools to ascertain if blood is present. This complication may develop days after the accident.

(3) Note the amount of urine. Have specimens sent to the laboratory for examination.

Electrical Burns.—Lightning Stroke.—The local effects on the skin are similar to those which have been described as the result of contact with heat. Frequently it is impossible to estimate the extent of tissue damaged until sloughing occurs. Formerly it was not infrequent to witness X-ray burns developing days after the exposure, and the resulting slough still later. The chief effects, however, of electrical burns from whatever source are manifested in the cerebro-spinal system and the deeper viscera of the body, the phenomena of which will vary from mere dizziness, headache, and general nervousness to the different forms of paralysis and the obliteration of the special senses. Rupture of internal organs as the result of lightning stroke is not uncommon. Instant death is frequent.

Local Treatment.—This is the same as has been advised for burns due to other causes.

Constitutional Treatment.—Artificial respiration may have to be employed and maintained at least one-half hour, together with cardiac massage. Maintain the body-temperature by the use of artificial heat. (See lecture on "Anesthesia—Anesthetics," section "Chloroform Accidents.")

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LECTURE XVIII

FREEZING AND FROST-BITES

The effects of cold on the human economy depend on several factors, viz.,

(1) The severity of the cold.

(2) The length of exposure.

(3) The humidity of the atmosphere.

(4) The velocity of the wind.

(5) The physical condition of the one exposed—the anemic and poorly nourished, the extremes of age and the alcoholic subject, are more susceptible to low degrees of temperature than those in the opposite physical state.

Classification.—

Freezing may be divided into *local* and *general.*

Local Freezing.—I shall consider three degrees of this condition.

First Degree.—This is characterized by a short interval of hyperemia. The blood-vessels are dilated and the skin becomes red, followed sooner or later by a contraction of the superficial blood-vessels with its accompanying anemia (lack of blood). Pain is more or less present at first. Gradually this latter symptom subsides, due to the anesthetizing effects of the cold on the nerve endings supplying the part. The one exposed is oblivious to the actual condition which is developing until some one calls attention to it, or upon entering a warm room the frozen part becomes swollen and painful. The contracted blood-vessels again dilate and sensation returns, the result of the thawing of the nerve endings. Anesthesia, however, may remain for several days. The results of this degree of frost-bite are either perfect restoration of the part to normal, or more or less permanent dilatation of the blood-vessels, producing unseemly blushes.

Treatment.—The popular method of rubbing the affected part with snow or other cold medium is proper, the idea being to gradually increase the temperature. *Under no consideration should warmth be suddenly applied* as in this way permanent changes in the blood-vessels may occur.

Second Degree.—This is manifested by the formation of blebs or vesicles. When conditions permit the development of the effects of cold on

the economy, the arteries remain contracted for a greater period than in frost-bites of the first degree. The outflow of blood from the capillaries to the veins is so reduced as to be inadequate to preserve a free return current toward the heart. *Blood-stasis* (slowing of the blood-current) *therefore occurs in the smaller veins, transudation of the blood-serum ensues, resulting in the formation of vesicles.* The local symptoms are the same as in frost-bites of lesser degree, *with the addition of vesicles.* The results of this accident are restoration to normal, unless an infection takes place when the blebs are ruptured. In such cases ulcers may develop, which at times are exceedingly difficult to heal, because of the dilatation of the vessels.

Treatment.—The primary principles of treatment are the same as in frost-bites of the first degree. After the appearance of blebs, the treatment will be similar to burns of the second degree with the usual precaution to prevent infection when the vesicles rupture spontaneously or are punctured.

Third Degree.—This is simply a condition in which the *blood-vessels have so contracted that the circulation ceases in the part;* or on account of the prolonged exposure, *the blood itself has become frozen* and the vessels filled with thrombi (blood clots). *The circulation is thus obliterated, the part receives no nutrition, gangrene or death of the tissues* is the result.

The process of repair will necessarily be *granulation tissue* (second intention) with its accompanying cicatrix. An entire member may be lost; or infection following the gangrenous process so severe as to produce a fatality.

The difference between burns and local freezing of the third degree is, that in the former one knows the extent of local injury at once, whereas in this class of freezing some days may elapse before it is possible to tell the *amount of damage the patient received.* In other words, it is impossible to foretell whether treatment will dilate the contracted blood-vessels and restore the circulation to the part.

Treatment.—When fears are entertained that the circulation is seriously damaged, Von Bergman's method should be utilized which consists in *suspending and immobilizing the member vertically* so as to favor venous return of blood. Gangrenous areas forming in spite of these efforts, warm, moist, mild antiseptic dressings are used locally. *Amputation of a member will not be undertaken until the line of demarkation has formed,* separating the dead from the living tissue.

Chilblains are simply repeated frost-bites which have damaged the local circulation and caused a proliferation (or increase) of the superficial and deep tissues. They appear chiefly on the toes, producing the discomforts of itching and pain when the feet become cold in winter. *Treatment is unsat-*

isfactory; tight shoes and clothing which constrict the part should be prohibited.

General Freezing.—The same conditions are present in general freezing as have been noted in local frost-bites, the only difference being the entire body is suffering from the effects of the cold, and the degree of penetration is greater. The superficial circulation is interfered with due to the contracted capillaries supplying the skin. The deeper blood-vessels sooner or later undergo a similar change, their caliber is contracted, consequently the nutrition and body-temperature are lowered until eventually the entire circulation is so impoverished that no barrier is left to offset the effects of the cold on the deep tissues. The heart's action becomes slower, and the vital centers of the cerebrum soon manifest their inability to functionate because of the lack of blood-supply. Respiration becomes more shallow and drowsiness soon develops. If the patient can find shelter or assistance this condition will possibly be overcome. If on the other hand, aid is not forthcoming, the intolerable sleepiness overcomes the sufferer and death ensues. Every fluid and tissue of the economy is frozen. One of the most impressive cases that has ever been brought to my attention was the following: A patient of mine moved from this city to one of the Western states and became a mail carrier for the government, making trips daily remote from habitation. Failing to make his appearance for a day or two, fears were entertained as to his safety. Searching parties were sent out and eventually found him standing in an erect position with one limb raised as in the act of taking a step, but completely congealed in a frozen mass, held in position by bushes and snowdrifts.

The question may arise as to how low the body-temperature can be reduced and still hopes entertained of recovery. Pilcher, in the American Practice of Surgery, says that cases of recovery have been reported in which the temperature was reduced to 76°, 80°, and 81°F., while Lexer-Bevan state that there is a possibility of resuscitation when the rectal temperature is not below 68° F.

The results of general freezing may be restoration to normal; or, when convalescence is apparently established, a fatality may suddenly ensue either from a *pneumonia, nephritis,* or possibly a *general infection* induced by the absorption of the disintegrative changes that have taken place in the tissues. You can easily understand that in cases of general freezing all forms of local freezing may be seen in different parts of the body,—that is to say, a second-degree frost-bite may be observed on one of the extremities, while an ear or the nose that was not in any way protected may be in a state of gangrene.

Treatment.—This should aim to prevent any rapid or sudden thawing of the tissues which would cause too rapid absorption of the large products of

blood-disintegration. The patient should be removed to a cold room and rubbed with snow, cold water, or given cold baths, the temperature *being gradually increased.* If respiration is impeded, artificial means should be employed to encourage this function. Atropin may be given hypodermatically, together with heart stimulants. The condition of the patient will be the best indication as to how long cold friction should be maintained. The temperature of the baths may be gradually increased until, possibly after three or four hours, the patient is brought to a temperature of 85° or 90°F. Warm stimulating drinks may then be administered and pain, which is usually intolerable when thawing begins, controlled by morphin.

Nurse's Duties.—These have practically been brought before your mind in my endeavor to impress on you the principles on which the treatment of freezing is based,—to prevent too rapid thawing, either in local frost-bites or in general freezing. In this latter condition, however, a relay of nurses will be necessary to carry out the hours of constant work which will be required before the patient is out of danger. The other details which will devolve on you can easily be gathered from your knowledge of the condition, remembering that even *though the patient's temperature and pulse have returned to normal, pneumonia may develop, or a nephritis insidiously ensue, or general infection* overwhelm the patient.

Your duties therefore will be to accurately chart the excursions of pulse and temperature and note the number of respirations. The amount of urine should be daily calculated, and specimens of this excretion sent to the laboratory for examination.

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LECTURE XIX

THE OPERATING-ROOM AND ITS EQUIPMENT

This room should be spacious and light—facing the North preferably—constructed with a large bay window and generous skylight; the floors should be of pure white tile, and the walls smoothly finished with cement plaster and white enamel. There should be no sharp angles or corners, and all unnecessary woodwork should be dispensed with. The corners of entrances should be rounded, and they should be without doors. The swinging of a door disturbs the atoms of atmosphere, besides which they are useless. The floor-plan of such an operating-room and its auxiliary rooms is clearly shown in illustration XLIII.

Heating.—This should be accomplished by hot water or steam, so arranged that the temperature is always kept at 70°F., but which can be instantly raised to 80°F. when the room is needed. In calculating the radiation of an operating-room 100 per cent. more should be installed than is ordinarily necessary, as the large amount of glass entering into its construction lowers the temperature rapidly. The fact that at any moment this apartment may be pressed into service necessitates facilities for quick heating.

Artificial Illumination.—This should be perfect and consist of a cluster of modern high-power Tungsten lights incased in a frosted globe suspended over the operating-table. The lights thus protected give a softer illumination and are easier kept clean. Tungsten frosted bulbs should also be installed in the ceiling. Electric sockets should be placed in convenient locations to the operating-table; to these are attached (when necessity demands) extension cords for a portable hand reflector, or the drill for bone work, or the cautery. Dirty electric cords dangling over the operating-table should never be used for such purposes. All electric currents should be manipulated by wall switches.

Water.—There should be an ample supply of sterile water, both hot and cold, with the faucets (controlled by foot levers) placed above a white porcelain (vitreous china) sink fitted with sanitary trap. The location of the water equipment should be in proximity to the nurse in care of the sponges;

this will obviate the necessity of her leaving her post of duty, which generally happens at the wrong moment.

Furniture.—The ideal operating-room should have only such furniture as is needed for practical use, and it should be of the modern aseptic type throughout.

(1) *The Operating-table.*—This should be so constructed as to enable the anesthetist to control the different positions without moving from his place at the patient's head, and disturbing the surgeon. It should be easily adjusted to the Trendelenberg, the reverse Trendelenberg or Hartley position (which latter is used for operations on the head and neck); it should also be so designed as to allow easy access for operations on the rectum and vagina, besides having the proper elevators for gall-bladder, kidney, and

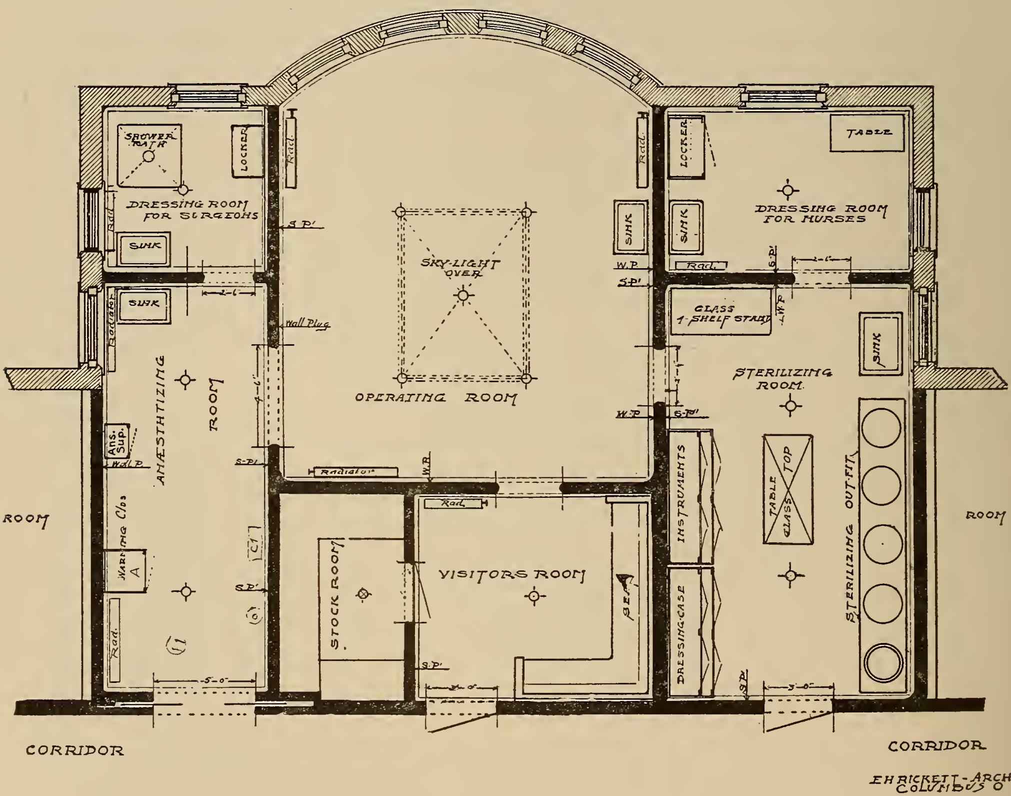

ILLUSTRATION XLIII

The Floor-plan of the Operating-room and Its Auxiliary Rooms.—Note the absence of any swinging doors opening into the operating-room, the accessibility of all rooms to the surgery,—en bloc, so to speak.

thyroid work, and head attachments for cranial work. It should afford good drainage for such solutions as are occasionally used in the secondary preparation of the patient, and should be equipped with casters of sufficient diameter to permit of its being easily moved from place to place, with a lock attachment to make it stationary when desired.

(2) *Stands*.—These are of regulation style. As a rule two are used, one on either side of the operating-table. The stand which is used for sponges

Illustration XLIV

An Ordinary Sponge- and Dressing-table.—Note the sterile dressings beneath preserved in their inner wrappers and suspended in a sterile swing.

and dressings is generally five feet six inches long by two feet wide, while the one devoted to ligatures and instruments is usually about three feet long and twenty-two inches wide. (See illustration XLIV and XLV.)

A much better arrangement is obtained by having two half-circular stands which enclose a space around the operating-table. These are six feet long on the inner circumference and fifteen inches wide. The surgeon and his assistants stand within the circle, the nurses on the outside, yet sufficiently close to attend to every want of the operator. If for no other reason these

are preferable because they keep the inquisitive visitor from getting too near the field of operation; moreover they afford ample table room for single or multiple major operations when performed in sequence. The tops and

ILLUSTRATION XLV

An Instrument-stand.—Note the basins filled with sterile water on the shelf for cleansing instruments during the operation.

shelves come in three sections, which facilitates their removal for cleansing purposes and lessens the expense in case of breakage.

(3) *A washstand* with two porcelain basins for the surgeon's use during the operation. This is dispensed with if the semicircular stands are used.

(4) *An adjustable instrument-stand* which is placed over the patient for the convenience of the surgeon.

(5) *An irrigating-stand* equipped with rubber casters to facilitate its being moved and fitted with glass percolators and rubber-hose attachments.

Illustra

The Operating-room.—By referring to illustration XLIII the rela

n XLVI

ı of this room to its auxiliary rooms will be appreciated

(6) *An anesthetist's table* for such articles as may be needed by the anesthetist.

(7) *Two metal stools,* one for the anesthetist and the other for the surgeon.

(8) *A waste receptacle* for soiled sponges, etc., constructed of steel and with rubber casters, the cover of which is operated by a foot lever.

(9) The necessary number of *basins* and *pitchers,* generally six of each. (See double-page illustration XLVI.)

Care of the Operating-room.—It is of the highest importance that this room and its furniture be kept in the most aseptic manner. Investigations indicate that strict attention should be given the condition of the walls and floor of this apartment. The *walls and ceiling* should be thoroughly *cleansed with soap and water at least every two weeks;* the floor mopped carefully with corrosive-sublimate solution 1:1000, or carbolic-acid solution 1:20, *every morning previous to operating,* and with plain water between operations *unless pus has been encountered,—then rely on one of the above disinfectants.*

The tables, stands, etc., should be washed with water and one of the numerous soap-powders which are found on the market, then carefully rinsed and dried after operative procedures are completed for the day.

The basins and pitchers are cleansed in the same manner, then stored. An extra supply of these utensils should always be kept on hand.

The instruments should be carefully washed with soap and water after each operation; if rusted they should be scoured with sapolio, rinsed, and dried. Hemostats and scissors should be taken apart before going through this process and finally paired before being returned to their case. Cutting instruments must be kept sharp. No one thing interferes with the efforts of a surgeon as much as dull knives and scissors. The needles are cleansed in a similar manner, scoured with emery dust if rusted, the eyes and points inspected, assorted, and placed in their respective glass containers.

The bone drill, electric cautery, and portable hand reflector should be under the supervision of the head nurse, whose duty it is to see that they are kept in perfect condition; it is exasperating to have occasion to use one of these instruments and find they are not in service.

The bottles containing the various drugs *which are used* in the operating-room, *but which are kept in the sterilizing-room,* should receive daily attention by being cleansed with gauze moistened in some antiseptic solution.

Surgeon's and Nurses' Dressing-rooms.—A similar architectural construction is followed in these rooms as heretofore suggested. These apart-

Illustration XLVII

Surgeon's Dressing-room.—By referring to illustration XLIII the relation this room bears to the operating-room will be seen.

Illustration XLVIII

Nurses' Dressing-room.—By referring to illustration XLIII the relation this room bears to the operating-room will be seen.

ments should also connect with the operating-room. (See illustrations XLVII and XLVIII.)

Furniture Equipment for Each Room.—(1) A large porcelain (vitreous china) sink with several faucets connected with hot and cold sterile·water under foot control.

I must be pardoned for not agreeing with the usual advice given in every text-book on hospital equipment, in preferring the porcelain sink I have described above to individual basins with the multiplicity of traps, faucets, etc., with which they are equipped. The increased mechanism makes them more difficult to keep clean than one large open sink. I also desire running water during the process of hand sterilization, and not use same water over and over again as is commonly seen when the individual-basin system is employed. Skin sterilization depends on *dilution* more than anything else.

(2) A small aseptic table for the soap and brushes should be within easy access to the sink.

(3) A large table for the packages containing the sterile gowns, suits, etc.

(4) Clothes-hangers for the surgeons' coats and nurses' uniforms.

(5) A shower bath is a refinement which the surgeon appreciates in his apartment.

LECTURE XX

TECHNIC OF THE OPERATING-ROOM

In previous lectures I have given you the cause and nature of infection, and the artificial means employed to prevent it; the principles of asepsis and antisepsis; the value of sterilization; the best methods for preparing the various dressings and other materials used in surgery. I have described the operating-room, its furniture, and the care which should be bestowed on this apartment to keep it to the highest standard of surgical cleanliness. I have described the means employed by different operators for the sterilization of hands. I have given each succeeding step in the preparation of the patient who is to undergo a surgical operation. I desire now to put into practical use the knowledge thus gained by starting the "machinery" of the operating-room.*

As a rule three nurses are assigned, the head operating-room nurse and the first and second assistants; the latter is called the *"non-sterile nurse,"* inasmuch as she will be called upon to perform such duties as prevent her from maintaining a sterile toilet.

Nurses' Preliminary Toilet.—Probably an hour before the operating-room is required, the nurses adjourn to their dressing-room and prepare their personal toilet as follows:

(1) Remove hospital uniform.
(2) Assume sterile gown.
(3) Adjust head covering.
(4) Cleanse hands according to one of the methods described.
(5) Put on one pair of rubber gloves. (The non-sterile nurse is exempt from this step.)

The operating-room floor has been carefully mopped with mercuric solution 1:1000, or carbolic acid 1:20, by an orderly properly gowned.

Preliminary Duties of the Non-sterile Nurse (Second Assistant.)—(1) Cleanse all tables and stands with mercuric solution 1:2000, or carbolic acid 1:20.

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* The student is advised to carefully read the lecture on "The Equipment of the Operating-room," to form a comprehensive idea of the various steps suggested in this lecture.

(2) With the usual antiseptic solutions cleanse the bottles containing the various drugs and stock solutions, glass receptacles which contain other articles that may be needed during the operation and place the same *on the glass table in the sterilizing-room.* The following is a practical list:

(a) Corrosive sublimate tablets for making mercuric solution.

(b) Ether, or 5-per cent. iodin-benzin compound, or Harrington's solution for the final preparation of the field.

(c) Tincture of iodin.

(d) Alcohol.

(e) Carbolic acid.

(f) Iodoform gauze and tape.

(g) Drains of assorted sizes.
(h) Catheters, assorted sizes. } Sterilized and in individual containers.

(i) Adhesive plaster.

(3) Remove from the cupboard and place on *the glass-top table in the sterilizing-room* the double-wrapped packages containing sterile dressings, sponges, towels, gowns, suits, gloves, celiotomy sheet, etc.

(4) Loosen the outer wrappers, *being careful not to interfere with the inner coverings* which are sterile. *Thus any of these packages may be opened during the progress of the operation without the nurse contaminating her sterile gloves, which would not be the case if only single wrappers were used.* (See lecture on "Preparation and Sterilization of Gowns, Dressings," etc.)

(5) Sterilize the necessary number of basins and pitchers, together with the irrigator (if this latter is to be used).

(6) The necessary instruments having been selected (this is generally the duty of the chief operating-room nurse or first surgical assistant), they with needles and non-absorbable suture material are placed in the appropriate sterilizer and boiled. The knives and scissors are cleansed with soap and water, dipped in carbolic acid for a few minutes, and placed in a receptacle filled with alcohol.

(7) In an appropriate vessel immerse the hermetically sealed tubes of catgut in mercuric solution 1:2000 until needed.

Preliminary Duties of the First Assistant Nurse.—

(1) Cover instrument-stand and sponge- and dressing-table with sterile towels.

(2) Tie a strip of sterile gauze around each of the bottles and glass containers which have been selected and cleansed by the non-sterile nurse, and place them on *the shelf of the sponge- and dressing-table.*

(3) Place the sponges (wipe and abdominal), towels, celiotomy sheet, and gloves on the sponge- and dressing-table, *still retained within their inner cover.*

(4) The dressings, extra sponges, extra towels, extra gloves, etc., are located *on the shelf* of the same stand, preserved in their inner wrappers.

(5) Take the suits, gowns, and gloves for the surgeon and his assistant to their dressing-room.

(6) Distribute the sterilized basins and pitchers as follows:

(a) Two or three basins and a similar number of pitchers on the dressing- and sponge-table, possibly an extra basin and pitcher on the shelf of the same.

(b) Two basins on the shelf of the instrument-stand.

(c) Two basins on the washstand for surgeon's use during the operation.

(d) Cover all basins with sterile towels until filled with solutions.

(7) Remove the instruments from the sterilizer and place on the instrument-stand, together with needles and the different suture and ligature materials, and cover with sterile towels. Place the extra instruments which have been sterilized for any emergency on the shelf of this table and protect in the same manner.

(8) Adjust the sterile slips to the operating-table pads and *remove the table to the anesthetizing-room.* This is the place to transfer the patient from the ward car to the operating-table *and not in the operating-room.*

Preliminary Duties of the Head Nurse.—During the various steps which have been carried out by the subordinates, the *head operating-room nurse* has supervised the many details and suggested any changes from the general routine which she considers beneficial to the case in hand, besides outlining the plan of work for the subsequent operations of the day.

On the arrival of the surgeon there are three procedures that generally take place simultaneously—

(1) The surgeon and assistants repair to their dressing-room, assume operating suits and shoes, and sterilize hands.

(2) The chief operating-room nurse and first assistant adjourn to their apartment, change gowns, and sterilize hands. The former assumes two pairs of gloves, the latter one pair of gloves and bib-apron; they then return to the operating-room.

(3) The patient has been brought from the ward and is being *anesthetized on the operating-table.* If ether or chloroform is the anesthetic of choice,

this is accomplished in the anesthetizing-room; if nitrous oxid-oxygen, the administration occurs in the operating-room.

Celiotomies.—Inasmuch as the majority of major operations occur in this region, I will give you the routine to be carried out to perfect the technic of such an operation.

Final Duties of the Non-sterile Nurse.—After the patient is anesthetized the non-sterile nurse carries out the following schedule:

(1) Remove the ward blanket and sheet which cover the patient.

(2) Secure the patient's hands to the sides by the use of towels folded lengthwise, four-ply: one end of the towel is wrapped around each wrist two or three times, the other end is tucked under the buttocks. Thus the weight of the body holds them in place; or the hands are held by straps attached to the operating-table.

(3) Fold the nightgown upward on the chest.

(4) Cover the thorax with one of the small blankets prepared for that purpose and adjust the other over the lower extremities within a short distance of the pubis.* (Some operators require these blankets covered with rubber sheeting.)

(5) Resterilize hands, assume sterile gloves and bib-apron.

(6) Assist surgeon in assuming gown and gloves.

(7) Be prepared to lend such assistance as may be needed during the operation.

The patient, being anesthetized, is wheeled from the anesthetizing-room into the operating-room if ether or chloroform has been administered, but where nitrous oxid-oxygen is the anesthetic the administration is accomplished in the surgery.

Final Duties of the Head Nurse.—

(1) Remove the protective dressings from the field of operation and place them in the waste receptacle.

(2) Make the final preparation of the field according to the method of the individual operator. The majority of surgeons at the present time rely solely on sponging the field with

(a) Ether or alcohol and finally painting the same with tincture of iodin; or,

(b) Harrington's solution, neutralized with alcohol, and finally painting with tincture of iodin; or,

* Note *the protective dressings* employed at the *primary preparation* of the field have not been disturbed.

(c) Employing a 5-per cent. iodin-benzin mixture. Any one of the three methods is efficient.

(3) Carefully cover the blankets (or the rubber sheets if these are used) with sterile towels moistened in mercuric solution 1:2000.

(4) Cover the patient and table with the celiotomy sheet, the aperture in which corresponds with the field of operation. (See illustration XLIX.)

(5) Assist in placing the patient in the required position.

Illustration XLIX

A Celiotomy Sheet which is draped over the blankets, patient, and table immediately before the operation is begun. Note the opening in the celiotomy sheet through which the operation is made.

(6) Remove outer pair of gloves and assume bib-apron.

(7) Assume position at the instrument-stand and carry out the following duties *during the operation:*

(a) Cleanse blood-stained instruments.

(b) Have pus-besmeared instruments resterilized before being returned to the instrument-stand.

(c) Prepare sutures and ligatures the desired length, thread needles and mount them in their holders or arm ligature-carrier ready for use.

When needed by the surgeon *the handles of these instruments are presented and not the jaw of the needle-holder*, or the *transfixion part of the carrier.* Such an error mars the surgical reputation of the nurse and grates on the sensibilities of the surgeon.

The head nurse has been chosen to look after the sutures, ligatures, and needles because she is familiar with the technic of the individual operator. All surgeons have their own ideas along these lines, some use catgut of various sizes for different steps, while others employ one standard size for everything. Some operators prefer a long ligature, while others claim a short strand is easier tied. Some close the abdomen by the *"tier method"—that is each tissue entering into a wound is stitched separately, tier by tier;*

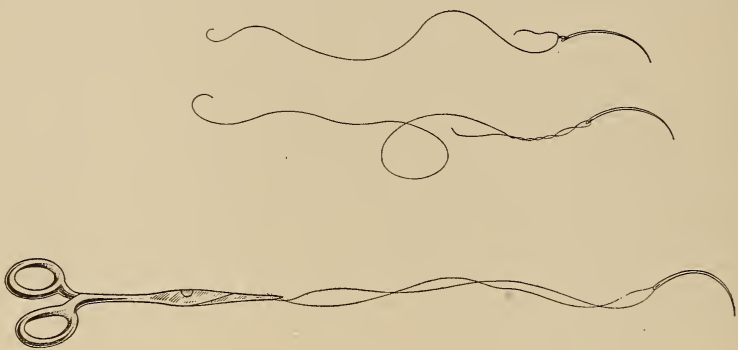

ILLUSTRATION L

The proper manner in which needles should be threaded before being placed in the needle holder and passed to the surgeon. The first picture shows a single strand of catgut tied in the eye of the needle. The second illustrates silkworm gut twisted on itself, while the third shows a double strand of catgut clamped at the ends to maintain an equal length.

while others use a *"through-and-through" suture and close the incision "en masse,"* so that it is necessary for a nurse with large experience to be intrusted with this important duty. In a general hospital where several surgeons use the same operating-room and nurses, a standard size and kind of suture material should be agreed upon. I use No. 1 chromocized catgut for everything, except cosmetic surgery of the face. This simplifies matters and is conducive to rapid work. (See illustration L.)

Final Duties of First Assistant Nurse.—

(1) Remove inner covering from wipe and abdominal sponges and towels. The dressings remain in their inner wrappers until needed.

(2) Count abdominal sponges and have the same checked by the head nurse. This is *the fourth time* these articles have been counted.

(3) Place abdominal sponges in one of the basins on the sponge- and dressing-table.

(4) Prepare solutions. These have been left to the last so as to be warm when needed. The following will be required:

(a) Normal saline solution in the basins and pitchers on the sponge-table to be used for cleansing the sponges.

(b) A similar solution in the basins on the shelf of the instrument-stand for cleansing the blood-stained instruments.

(c) Normal saline solution in one of the basins on the surgeon's wash-stand, mercuric solution 1:2000 in the other. (I prefer Harrington's solution in this latter basin.)

(5) Assume position at the sponge- and dressing-table and handle the sponges during the operation by observing the following rules:

(a) Keep the solutions warm and clean, not cold and bloody.

(b) Cleanse each sponge before it is used again.

(c) Always have a sponge ready for immediate use, so as not to retard the surgeon.

(d) All sponges *soiled with pus* are thrown in the waste receptacle and not returned to the sponge-basin.

(e) Have an ample supply of extra sponges ready for use in cases complicated with pus or severe hemorrhage. *Extra sponges which are called into service must be counted and finally checked by the head nurse before being used.*

(f) Keep an accurate count of all sponges.

The first assistant nurse has been selected to perform the duties assigned her because she appreciates surgical cleanliness, and realizes the necessity of maintaining a condition of sterility throughout the operation. Her experience in the various steps in the operating-room qualifies her to preside over the sponges,—a task of no mean importance.

The Operation.—For the sake of illustration suppose the case in hand is one of pelvic disease. The patient is in the *Trendelenberg posture;* the surgeon stands on one side of the table, the first assistant opposite. On the adjustable instrument-stand (which is conveniently located over the patient) have been placed hemostats, knives, and scissors, together with a few dry wipe sponges for cleansing the abdominal wound.

After the incision is made the wipe sponges are *immediately removed* by the assistant and placed in the waste receptacle, not thrown on the floor as is occasionally done. Some surgeons use the ordinary abdominal sponge to

cleanse the incision instead of the small wipe sponge, but this can hardly be considered good technic.

Abdominal sponges are now introduced within the peritoneal cavity to retain the intestines in the higher abdomen and protect this cavity should infection be encountered in the pelvis, besides affording a clear field for operative interference.

Such organs as are diseased are removed, blood-vessels ligated, and the intra-abdominal wound repaired. It is just at this point that the experienced head nurse handling the ligatures and sutures becomes an asset to the surgeon. If she is acquainted with his technic she anticipates the length of suture necessary, whether single or double, and the kind of needle which is desired, thus relieving the surgeon of that detail. The best operator appears as an amateur with inexperienced assistants. On the other hand the mediocre surgeon with well-trained help accomplishes feats beyond his natural dexterity.

The intra-abdominal portion of the operation being accomplished the surgeon removes all sponges from the cavity and inquires from the sponge nurse if the count is correct; she at once enumerates them and replies, a check being made by the head nurse, who for the moment leaves her position at the instrument-stand. Thus these articles have been *counted six times.*

The abdomen is now closed according to the individual method of the surgeon. The surgical assistant cleanses the abdominal incision and dries the patient's back. The sponge nurse has the dressings (abdominal outfit) ready which are then applied as follows:

(1) The fluffy gauze covers the field of operation.

(2) Cotton-gauze pads cover this dressing.

(3) The abdominal binder is adjusted. (See lecture on "Preparation and Sterilization of Gowns, Dressings," etc., section "Bandages.")

The non-sterile nurse in the meantime has obtained a nightgown and blankets from the warm closet in the anesthetizing-room. The gown is substituted for the one the patient wore during the operation; the blanket is wrapped around the patient, and the transfer from the operating-table to the wheel car is made. This is the proper place for a change of clothing,—the temperature of the room is appropriate and the gown can be easier adjusted than when in bed. The patient is then returned to the ward or room.

In my opinion the routine outlined above is near the ideal for the following reasons:

(1) The transfer of the patient from the wheel car to the operating-table is made in the anesthetizing-room before the anesthetic is begun.

(2) The patient is kept comparatively dry throughout the operation. If the plan of deluging the patient with large volumes of soap and water in the final preparation is carried out, the following is the result:

(a) The patient lies on a wet bed during the operation.

(b) This adds to the reduction of body-temperature, which the operation is also influencing.

(c) Hence, it lowers body-resistance and invites shock.

(d) The operating-room was never intended as a lavatory.

(3) The nurses have been chosen for their duties because of their individual qualifications.

Modifications of Technic for Special Locations.—

(1) *Operations on the Head.*—The Hartley position is employed to facilitate venous return. (See illustrations XXVI and XXVII.) In addition some form of head rest is utilized, every surgeon having some special device. After the final cleansing of the field, which is the same as in other locations, the head nurse covers the scalp with two- or three-ply gauze (20 by 24 mesh) held in place and kept smooth by an elastic tourniquet, which also prevents hemorrhage from the scalp,—a field where the blood-supply is very rich. Before operative procedures are begun the surgeon cuts an opening through the gauze corresponding to the size and location of the field. This extemporized gauze skull-cap is simply another means to prevent contamination of the hands of the operator, even though the scalp has been shaved and the field passed through a most thorough process of sterilization. In cases where only a *local* depilation has been made as in operations for mastoid disease, I prefer a rubber cap such as can be purchased at any instrument store. This protects the hair from blood-clots and is self-retaining. It is sterilized like other rubber goods.

The sponges used in intracranial operations are small pledgets of gauze made at the time, and so folded as to practically conceal all loose fibers of the material. Hemostats are attached to facilitate their use. An ample supply is necessary, as venous oozing is generally very profuse. Prepared cranial sponges in small resections of the skull are clumsy, although possessing the advantage of having no raw edges. In nearly all cases the ordinary wipe sponge is out of proportion except for the scalp incision.

The administration of an anesthetic in operations on the brain is accompanied with more danger than in surgical procedures in other locations. Shock is liable to manifest itself suddenly, and respiration cease without warning. The anesthetist therefore should provide an artificial-respiration apparatus as well as a sphygamomanometer, which latter instrument should be used throughout the operation by a special assistant, whose further

duties will be to operate the artificial-respiration apparatus if occasion demands. For as Cushing remarks in this connection, "breathing stops long before cessation of the heart-beat, which under artificial respiration may be kept up indefinitely. A number of patients have been rescued in this way."

(2) *In operations on the neck,* such as for goiter, the Hartley position is utilized together with a neck elevator. (See illustration XXVI.) This extends the neck, convexes the field of operation, and throws the gland more prominently forward. The final preparation of the field is the same as has been described for celiotomies. The ordinary wipe sponges are used. Plain

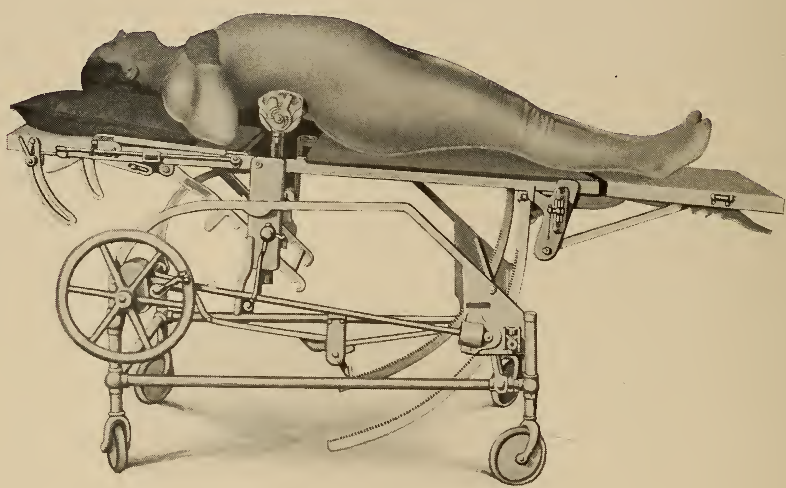

ILLUSTRATION LI

The Lilienthal Elevator in Position.—This elevator is used in operations on the liver and upper zones of the abdomen.

sterile-gauze dressings are employed, held in place by a roller bandage. The bandage *must not be snugly applied, as the pressure thus exercised may produce ill effects.* Compression will force an abnormal amount of thyroid secretion into the circulation, and jeopardize the life of the patient.

(3) *Operations on the Liver, Gall-bladder, and Hepatic Ducts.*—The patient is placed supine on the table, in such a manner that the Lilienthal elevator corresponds to the posterior site of the liver. The elevator is then raised to a sufficient height to produce a convexity of the upper abdomen. The liver is thus forced forward. If the head of the table is elevated slightly

the intestines gravitate to the lower abdomen. This method greatly facilitates the subsequent steps of the operation. (See illustration LI.) The final preparation of the field is the same as recommended for celiotomies. Ordinary abdominal sponges are employed for the work within the peritoneal cavity. Wipe sponges are used for the abdominal incision. If the operation is on the gall-bladder or ducts, a rubber drainage-tube is inserted and stitched in place with catgut. Occasionally a cigarette drain is used to afford a means of escape for fluids beneath the liver.

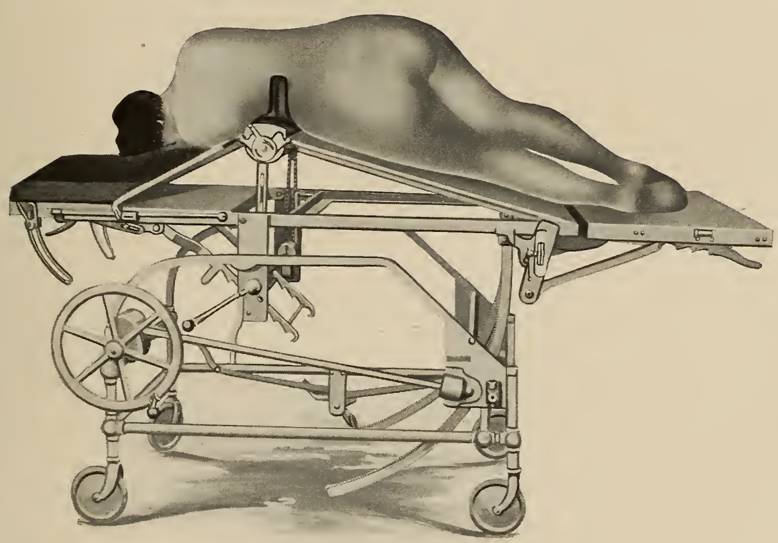

Illustration LII

The Cunningham Elevator in position for operations on the kidney. Note the padded standard at the back. A similar one is also used in front, by which means the patient is retained in position.

Dressings are applied as for any other abdominal operation, unless a drain is employed, in which case the following modifications are made:

(a) Fluffy gauze is so placed on the wound as to permit an exit to the drainage tube.

(b) A portion of gutta-percha tissue or oiled silk of sufficient size to cover the fluffy-gauze dressing is next applied, an aperture being made through this protective to accommodate the passage of the drain.

(c) Cotton-gauze pads are next adjusted.

(d) Finally the abdominal binder is utilized to hold the dressings in place, the tube being allowed to protrude through it. Gutta-percha tissue or oiled silk is used in an endeavor to prevent the outer dressings from becoming soiled with the discharge. Frequently a dermatitis is produced by the excretion. When this complication occurs some demulcent, such as the officinal oxid of zinc ointment, is applied to the skin.

After the patient is returned to the ward, the drain which projects from the wound and through the dressings is attached to a longer tube and conveys the discharges to a bottle suspended at the side of the bed. I may add, a similar procedure is instituted when drains are utilized in the urinary bladder.

Where the operating-table is not equipped with a Lilienthal or Cunningham elevator, or in private practice where an extemporized operating-table is utilized, sand bags are employed to produce the necessary elevation, but as can be easily understood they are inferior to the mechanical appliances spoken of.

(4) *Operations on the Kidney.*—One of the most difficult steps in operations on this organ is to secure a proper adjustment of the patient on the table. The Cunningham elevator which is used must be adjusted to the correct height, and the pressure of the elevator manifested in the right place, so as to lengthen the distance as much as possible between the last rib and the crest of the ilium—in other words, to increase the "working space." For the sake of illustration, suppose the right kidney is to be operated on. The patient is placed on the *left side* in such a manner that the top of the elevator will be just below the last rib; the trunk is *slightly inclined to the surface of the table,* and held in this position by heavy vertical padded standards attached to the Cunningham elevator, which is then raised. If the elevator is too high the muscles on the right side will be on such an excessive tension, as to interfere with the necessary manipulations; if not sufficiently elevated, the "working space" is not increased to a satisfactory extent. (See illustration LII.) The final preparations are the same as advised for celiotomies. An abdominal sponge or two may be required to place under the kidney after it is loosened from its bed and during operative interference. A cigarette drain is usually necessary, in which case the protective oiled silk is used to prevent the outer dressings from becoming soiled. Celiotomy dressings held in place by the usual binder are used.

Operations on the Vagina.—The patient is placed in the dorsosacral or lithotomy posture (see illustrations XXIII and XXIV) on a Kelly pad, pro-

vision being made for drainage. Some operating-tables are so constructed as to obviate the necessity for such a pad.

The secondary preparation of the vagina is best accomplished by thoroughly mopping the canal with Harrington's solution, neutralizing the same with alcohol, and finally irrigating with sterile water. I have no hesitancy in recommending this technic, as I have put it to some very severe tests.

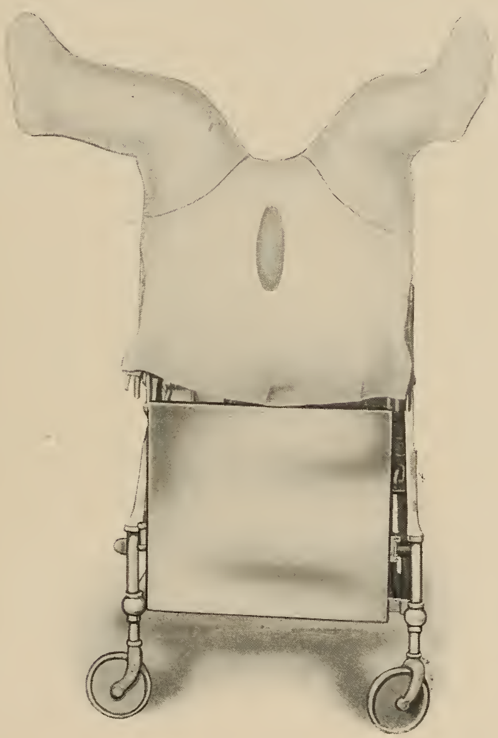

ILLUSTRATION LIII

A Lithotomy Sheet used as a protective covering in operations on the vagina, rectum, and perineum.

The usual method is by using a wipe sponge saturated with tincture of green soap and water to thoroughly cleanse the canal, followed by a douche of a 2-per cent. carbolic-acid solution.

A simple form of covering for a patient in a lithotomy posture is an ordinary muslin sheet in which three holes have been made; the center one

corresponds to the field of operation, whether it be the vagina, the rectum, or the perineum; to the lateral openings are sewed stockings made of a similar material to the sheet. After the patient is in the lithotomy posture, and the necessary cleansing of the field has been accomplished, this cover is applied by pulling on the stockings and draping the sheet around the subject. (See illustration LIII.)

After all I know of no better form of covering yet devised for protecting the patient than towels appropriately draped over the buttocks and extremities, the latter of course being previously covered with the long canton-flannel stockings with which the patient comes to the operating-room. The advantage is, when soiled these towels are easily replaced. Wipe sponges are used. The packing, if any is employed, should be iodoform gauze, because being an antiseptic it retards bacterial development in a very fertile field. The external dressings consist of a cotton-gauze pad held in place by a "T" bandage.

General Remarks.—The same aseptic care must be exercised in all operations. I am sorry to say there is an erroneous impression prevalent that if the peritoneal or cranial cavity is not the field for surgical interference, a high standard of asepsis need not be maintained. This is wrong. Pathogenic bacteria lurk everywhere. Fearful infections can occur in any tissue through lack of surgical cleanliness. If the truth were told, it would be proper to say that the abdominal serosa (peritoneum) can withstand more abuse and insults from a faulty technic than any tissue in the economy. Therefore, if *it* is entitled to the care generally bestowed on it, then other fields of operative interference should receive at least the same consideration. This is especially true of operations involving the joints where susceptibility to infection seems to be at the maximum. As trained nurses you should perform your duties in a thorough and painstaking manner, regardless of the nature of the operation.

LECTURE XXI

THE EMERGENCY OPERATING-ROOM

In every modern hospital an emergency operating-room is equipped for the care of such patients as have been injured. It would be inappropriate to take care of this unfortunate class in the general operating-room where celiotomies and cranial operations are performed daily. This emergency surgery must be kept to the highest standard of efficiency because this class of patients enter under the most unfavorable conditions. Nothing about them is sterile, they have suffered more or less shock, possibly they are depleted of blood, and often are so badly mangled as to necessitate major operations. Under such exigencies the nurse must play her part in the deftest manner, because this is vastly different from a planned operation where everything is sterile and in order, moving with clock-like regulation.

Emergency Operating-room Equipment.—The architectural construction is the same as that of the main operating-room, but very rarely is there a sterilizing- and anesthetizing-room connected with it; consequently, besides the regular equipment, additional furniture is needed so as to have all accessories concentrated in one room. Moreover a *sterilizing outfit* for water and a combination sterilizer for basins, pitchers, and instruments must be included. Time, which plays an important factor in emergency cases, is not to be lost. This room should always be kept to the highest point of efficiency. The additional furniture should consist of—

(1) An *aseptic cupboard* similar to the one described in the main sterilizing-room, for the storage of sterilized articles such as dressings, sponges, gowns, operating suits, caps, gloves, etc., besides clean blankets, rubber sheets, Kelly pad, hot-water bottles, etc.

(2) A *four-shelf glass aseptic stand,* a duplicate of the one in the main sterilizing-room, on which is kept the following:

(a) Stock solutions and mixtures.

(b) Drugs and antiseptics.

(c) Medicated-gauze preparations, as iodoform gauze and iodoform tape.

(d) Roller bandages and adhesive plaster in various widths.

(e) Basins and pitchers.

(f) Accessories such as urethral catheters (assorted sizes), drainage tubes (assorted sizes), stomach tube, complete infusion outfit with the necessary flasks of sterile normal saline solution. All of these accessories are sterilized and preserved in the manner previously described.

(g) Hypodermic syringe, needles, and tablets.

(3) A stand for the ordinary anesthetics with appropriate cones and inhalers, and a complete nitrous oxid-oxygen apparatus with extra tanks of these gases.

(4) A *surgical-instrument case* similar to the one in the main sterilizing-room filled with such instruments and mechanical accessories as are employed in emergency work.

Maintaining the Equipment and Efficiency.—*After every operation* any depletion in these stock supplies should be *immediately replenished,* and all instruments cleansed and replaced in the instrument-case; tables thoroughly sponged with the usual antiseptic solutions, dried with sterile towels, and covered with sterile sheets, which can be removed at a moment's notice; basins and pitchers sterilized and placed on the accessory-stand upside down; finally the floor mopped with mercuric solution 1:1000, or carbolic acid 1:20, and the *apartment closed.*

Emergency Operating-room Technic.—By way of illustration, suppose the case in hand is one of a mangled thigh. The patient is placed on the operating-table by the ambulance corps and the house surgeon notified, who will

(1) Observe if hemorrhage is present, and check the same temporarily if possible.

(2) If the patient is conscious and suffering severe pain, order morphin and atropin administered, or other narcotics.

(3) Ascertain the character of the pulse and order stimulants if necessary. These may include besides the ordinary heart stimulants transfusion or intravenous infusion of normal saline solution with adrenalin. (See lecture "Transfusion—Infusion.")

With these several factors under control the surgeon adjourns to the dressing-room and prepares his toilet.

Duties of Second Assistant, or Non-sterile Nurse.—

(1) Protect uniform with a gown (not necessarily a sterile gown).

(2) Remove soiled clothing from patient, cutting the same if necessary.

(3) Adjust clean nightgown to patient and maintain body-temperature with warm-water bottles and blankets, so arranged as to leave the injured area exposed. Cover the blankets with rubber sheeting.

(4) Remove soiled clothing from the operating-room.*

(5) Assume sterile gown and cap, sterilize hands, adjust gloves and bib-apron—await further orders.

Duties of Head Nurse.—During the time occupied by the non-sterile nurse in changing the patient's clothing, supplying artificial heat, etc., the head nurse should carry out the following duties:

(1) Adjust cap, assume gown, sterilize hands, and put on two pairs of gloves.

(2) Place Kelly pad under the injured member, shave and mechanically cleanse the field of operation; rinse with sterile water, remove Kelly pad.

(3) Protect the member above and below the field of operation with sterile towels moistened in mercuric solution 1:2000. Arrange sterile towels moistened in a like solution so as to cover the protective rubber sheeting.

(4) Remove outer pair of gloves and assume bib-apron.

(5) Complete sterilization of the field according to the views of the individual surgeon.

(6) Take position at the instrument-stand and have sutures and ligatures ready.

Duties of First Assistant Nurse.—

(1) Select instruments and place in the sterilizer, together with the necessary number of basins and pitchers.

(2) Remove coverings from the various tables and stands in the operating-room.

(3) Loosen outer coverings of dressings, towels, sponges, etc., *without touching inner wrappers. Allow them to remain in the dressing cupboard temporarily.*

(4) Assume cap and gown, sterilize hands, adjust a pair of gloves, and bib apron.

(5) Remove from the cupboard the dressings, towels, sponges, etc., still preserved in their inner wrappers and place them on the *shelf* of the sponge- and dressing-table.

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* *Anesthetization of the patient is now begun.* Nitrous oxid-oxygen is the anesthetic of choice. (See lecture "Anesthesia—Anesthetics," section "Indications and Contra-indications for Nitrous Oxid-Oxygen.")

(6) Remove inner covering from a package of towels. Use as many as are necessary to cover the sponge- and dressing-table and instrument-stand; place the remainder on the sponge- and dressing-table.

(7) Distribute the sterilized basins and pitchers as for a planned operation.

(8) Place sterilized instruments, with ligatures and sutures on the instrument-stand.

(9) Fill basins and pitchers with solutions similar to those described for use in the main operating-room.

(10) Remove the inner wrapper of the sponges and submerge these articles in one of the basins on the sponge- and dressing-table. The dressings are allowed to remain in their original wrappers until needed.

(11) Remove outer pair of gloves and adjust bib-apron.

(12) Take position at sponge- and dressing-table and be ready to handle sponges and dressings.

Thus each nurse has specific duties to perform; no time is lost. This is as it should be. The well-trained nurse is a disciplined soldier. There is no need for the hurry and panic that are so commonly seen even in hospitals where emergencies are frequent. The fault lies in lack of discipline, lack of attention to detail, lack of method—and the consequence is the patient suffers because of a lack of organization.

The Emergency Patient.—The victim of an accident is not prepared for a surgical ordeal; the intestinal tract has not been emptied, possibly the emergency occurred soon after a meal and hence the stomach has not had time to expel its contents; possibly, too, the subject is an alcoholic, or a sufferer from chronic Bright's disease, none of which conditions has been investigated. Such a patient deserves the closest attention and care, both at the time of operative interference and after. From the very nature of things *the greatest antiseptic precautions should be taken.*

Immediate Complications.—

(1) *Vomiting.*—Because of having received no preparatory treatment, this symptom may give a great deal of trouble during the administration of the anesthetic, especially if ether or chloroform is employed. Frequently it is desirable to lavage the stomach before beginning the operation, unless the accident is a penetrating wound of the abdomen: under such conditions this *step should certainly be omitted,* because should the stomach have been

punctured it will only cause a dissemination of infectious material throughout the peritoneal cavity.

(2) *Shock* and *Hemorrhage.*—Both of these conditions have been explained and the treatment given in the lectures devoted to these subjects.

Later complications are dealt with in the lecture devoted to "Some Post-operative Complications."

Room Assigned for Splints and Other Artificial Supports.—Adjacent to the emergency operating-room there should be a small room or closet set apart in which to store splints and the various materials from which they are made, extension apparatus, plaster of Paris in bulk, plaster-of-Paris bandages, silicate of soda, etc. (See lecture on "Fractures," section "Dressings Employed.")

LECTURE XXII

PRINCIPLES AND PRACTICE OF POSTOPERATIVE NURSING

Following operations of any magnitude there is always more or less depression, due to the influence of the anesthetic and the debilitating effects of the surgical procedure,—in some cases shock is present.

Assignment of Nurse.—As a preparatory measure the supervising nurse of the floor to which the patient belongs assigns one of her assistants, whose duties will be the following:

(1) To ascertain the position in bed the surgeon desires the patient to be placed after the operation, and arrange the bed accordingly.

(2) To obtain the surgeon's views with regard to the use of morphin if the patient suffers severe pain, and his wishes as to the time to administer water.

(3) To remain at the bedside until the patient becomes conscious.

(4) To prevent any unnecessary movements.

(5) To keep the patient covered.

(6) To lend such help as is necessary during the stage of nausea and vomiting.

(7) To count the pulse every half hour, note its character, and take the temperature every two hours, carefully charting both signs.

(8) To observe the respirations, if free and easy, or labored and sighing, or impeded; if the latter, and the character of the pulse and temperature are satisfactory, it is due to a constriction of the larynx. Under such circumstances grasp the lower jaw and pull it forward and upward.

(9) To remove the artificial heat when proper reaction has occurred.

(10) To add such comforts as come within her province.

Positions of Patient in Bed Immediately Following Operation.—The position the patient is to assume in bed depends on three factors—

(1) The nature of the operation which has been performed.

(2) The individual views of the operator.

(3) The condition of the patient.

Celiotomies (*Abdominal Operations*).—Some operators utilize *the Fowler position* from one to three days after all abdominal operations, excepting in cases complicated with shock; maintaining, and correctly so, I think, that even *though there is no suppuration, no apparent infection present,* the operative procedures may have set free latent microörganisms, or during the operation bacteria may have been introduced, and hence to be conservative this position is used in all cases for the first day or so. These operators base their reasons for considering this posture after abdominal operations less hazardous for the patient upon certain well-known anatomic and physiologic principles which I have already mentioned when speaking of the Fowler position, viz.—

(1) There is a constant peritoneal current from the pelvis to the diaphragm

(2) The nearer the *erect position* of the body, *the more* is the current retarded.

(3) The pelvis contains comparatively *few lymphatics,* therefore absorption is slow at this point.

(4) The region beneath the diaphragm is *richly supplied* with lymphatics, and absorption is consequently *rapid* in this locality.

(5) Hence, the elevation of the trunk of the body (Fowler's position), slows the peritoneal current, and any infection in the lower abdomen is *retarded in its progress* toward the rich absorbing fields beneath the diaphragm. The patient therefore is not *suddenly swamped* by a rapid absorption of infection, but *sufficient time is given* the economy to increase the resisting power and offset the invasion. (See lecture on "Positions or Postures of the Patient Utilized in Surgery.")

Other surgeons are satisfied to allow the patient to assume the ordinary *flat recumbent position* after abdominal operations, and only utilize the Fowler posture when the case is *one of suppuration* or *acute infection is known to be present.*

Extremities—Thorax—Cranium.—After most operations on the *extremities* the *flat recumbent* position is universally selected. In certain *cranial* operations *Fowler's posture* is utilized to assist in checking venous oozing, etc., while in surgery on the *thorax* for the removal of fluids, this position is used to assist drainage.

In cases complicated with shock or hemorrhage all surgeons require *the elevation of the foot of the bed* 30° *to* 45°, *without regard to the kind of operation,* to assist the demoralized circulation and maintain blood-pressure around the vital centers in the brain. (See lectures on "Surgical Shock"

and "Hemorrhage.") Thus I may say there are three positions in which the patient may be placed after an operation—

(1) The head-up or Fowler's position.

(2) Head-down or foot-elevated position.

(3) Flat recumbent position.

Preparation of the Fowler Position.—The various mechanical means employed to obtain this position have already been given in the lecture devoted to "Postures or Positions of the Patient Utilized in Surgery." (See illustrations XXVIII, XXIX, and XXX.)

In discussing the further preparation of this position, I shall take the liberty to describe the manner in which the Howell bed-frame is used—

(1) The bed is spread in the usual manner with sheet and draw sheet, between which is placed a rubber protective.

(2) Place the bed-frame on the bed, elevating the back support 35°, the foot elevation somewhat less.

(3) Pad the frame with pillows, and cover with a blanket.

(4) Place a quilted pad on the blanket at the site of the buttocks.

(5) Double blankets to serve as a cover for the patient are now placed on the frame.

(6) Between the double blankets and the one used to cover the frame locate four or five warm-water bottles (120° to 130°F.) wrapped in towels.

(7) The patient is laid beneath the double blankets when returned to bed and the warm-water bottles rearranged.

As a substitute for the bed-frame the head of the bed may be raised by an elevator similar to the one illustrated in the lecture on "Positions or Postures of the Patient Utilized in Surgery."

Flat Recumbent Position.—Prepare bed in the manner just described, omitting the frame and pillows (steps 2 and 3). The objection to pillows under the patient's head during the period of unconsciousness is that they force the head too far forward on the chest, thus constricting the larynx and interfering with respiration. Pillows may be used, however, when consciousness returns.

Head-down or Foot-elevated Position.—Prepare bed as in *flat recumbent position.* Elevate the foot of the bedstead by means of an elevator or substitute chairs, blocks, etc. This is the so-called "Shock Bed." (See illustration XXXVI.)

Frequently great comfort is obtained by folding a pillow on itself and placing the same beneath the flexed knees. This as you can easily understand relieves the tension of the abdominal muscles when the case has been

a celiotomy, and in operations in other parts it affords a change of position and rests the patient. This will not interfere with any of the above postures which may have been ordered by the surgeon. *The indiscriminate moving of the patient from side to side should not be allowed for the first twenty-four hours, and not then, if the general condition is unfavorable.*

Artificial Heat.—It is not necessary, in fact it is obviously wrong, to fill the bottles with very hot water which are used to stimulate the patient. The excessive high temperature thus produced in the bed only causes a further depression of the vital forces of the patient, which should not be further reduced, but rehabilitated. Serious burns have occasionally been produced by these hot bottles coming in contact with the unconscious patient, a very deplorable accident, one not easy to conceal, and still more difficult to explain to a jury. Such an injury is the result of negligence on the part of the nurse who is the agent of the hospital which employs her, and hence, the institution is responsible for her careless acts of omission and commission. If such an unfortunate occurrence happens in private practice the nurse who is in the employ of the family, is personally held responsible and liable for damages, even though she was recommended for the position by the surgeon. But in either case, for some unknown cause, the patient holds the surgeon equally to blame (which of course is erroneous), and everything is done to draw him into a lawsuit and injure his reputation. *The artificial heat is gradually withdrawn* as the patient's recuperative powers assert themselves; one by one the bottles are dispensed with, then the blankets which were wrapped around the patient in the operating-room are removed until finally after twelve or fifteen hours, if there are no contraindications the toilet of the bed consists of the usual bedsheet, rubber protective, drawsheet, and a blanket and sheet that cover the patient.

Nausea and Vomiting.—I do not think these distressing symptoms are as frequent at the present time as formerly (at least this has been the observation in my own practice), since the advent of the expert anesthetist. The nicety with which the anesthetic is administered, the care which is exercised in not giving any more than is absolutely necessary to keep the patient under its influence, is in strong contrast with the deluge of anesthetic which was formerly the practice. Moreover since the use of nitrous oxid-oxygen is becoming more general, nausea and vomiting are rarely seen. I also know positively the thirst after abdominal operations which was a bete noire to both surgeon and patient is greatly lessened, and nephritis and pneumonia following anesthetics are practically things of the past. Anticipating that nausea and vomiting may ensue, the nurse assigned to the case

for the first few hours after the operation should have in readiness a basin and extra towels to meet this emergency.

These distressing symptoms as a rule will subside after six or eight hours; but occasionally continue for days, and become a source of great worry to the surgeon and exhaust the patient. There are no drugs in use which give much, if any relief; this I say in spite of the numerous remedies which have been advised. Lavaging the stomach should be tried. It is hardly necessary to state that during this stage no fluids should be given by the mouth, as they only serve to irritate the already irritated stomach. The intense thirst may be somewhat relieved by small pieces of ice placed in the mouth, allowed to melt, and then expectorated. If the nausea and vomiting continue for days, or the patient becomes exhausted, proctoclysis and nutrient enemata must be employed. (See section in this lecture on "Rectal Feeding," also lecture on "Transfusion—Infusion," section "Proctoclysis.") In exceptional cases when the vomiting is of such severity as to produce dangerous exhaustion, a full dose of morphin hypodermatically will be ordered to afford rest. The sponging of the face and hands and the frequent use of some alkaline antiseptic mouth wash such as may be made from Seiler's tablets, are little niceties which add to the comfort of the patient. In abdominal cases if these symptoms have subsided and return after the administration of fluids, it is not always due to the effects of the anesthetic, but may be suggestive of infection developing or an obstruction forming, especially *if accompanied with pain, distention, increased pulse and temperature.*

Pain.—The administration of morphin for the relief of pain *immediately following* surgical operations is well indicated. I have frequently referred in my lectures to *rest* as a primary factor in the treatment of all surgical cases,—rest to the part which has been injured, rest to the infected area, rest to prevent the spread of infection. I desire to impress on you whatever means may have been employed to keep the local part at rest are to a great extent nullified unless the patient's entire system is placed in the same condition. There are some surgeons, however, who oppose the use of morphin after *abdominal operations,* claiming that the administration of this drug produces nausea and vomiting and encourages constipation and flatus with its accompany tympanites (distention of the intestines with gas)—in other words, digestive disturbances are the sequence. Personally I much prefer seeing the patient rest comfortably under the influence of this drug, allowing the nervous system to recuperate from the depression of a surgical operation, than tossing wildly in bed from side to side, and thus producing further exhaustion. The use of morphin under such conditions is surgical and sane. It is your duty to obtain the surgeon's views on the subject before administering this drug. If morphin is denied, it is not the nurse's duty to

exercise physical force to restrain the patient, as more harm can accrue therefrom than if left alone. This is the time for all the gentle tactics a nurse possesses.

In operations in regions other than the abdomen, I do not think there is any division of opinion as to the advisability of using morphin for the relief of pain immediately following surgical interference.

Pulse and Temperature.—The pulse and temperature should tend toward the normal after any surgical procedure, hence it is an inviolate rule that the closest attention be given these two important signs for the first day—in fact, from the time an operation has been performed until convalescence is established, the patient's condition is fairly gauged by the pulse and temperature. *During the first six hours after operative interference the pulse should be counted every half hour and close observation paid to its character.* If its rate tends to the normal, or at least its frequency is not increased, and the character of good volume, it may be assumed that the patient is recuperating from the depression of the operation, or at any rate is not retrograding. *If on the other hand the pulse becomes more rapid, its volume diminished, and the general character enfeebled, it certainly may be concluded that the patient is not rallying from the effects of the operation.* If in connection with this important sign *the temperature is taken every two hours* (or more frequently if necessary) and the thermometer readings indicate that the depressed body-heat (which is common after operations) is rising toward the normal in the same proportion as the pulse-curve is tending that way, there is a confirmatory indication that the recuperative powers of the patient are asserting themselves. *But if the body-temperature is sinking more and more, and the pulse becoming faster and faster with decreased volume, there is prima facie evidence that something is occurring which should receive immediate attention*—probably shock or hemorrhage. Because these signs are in a favorable condition *when first observed* is no guarantee they will remain so; hemorrhage may stealthily ensue hours after; or shock postponed, take place later. Hence, the rule to which there is no exception, the *patient's pulse should be counted every half hour for six hours, the temperature taken three times during this period, and for the first day repeated inspections made of the patient to ascertain the true condition.* This may seem unnecessary, but instances have impressed me with its necessity.

A pulse of 100 to 110 and a temperature of 100°F. occurring between the second and third day should not as a rule cause any anxiety in a large majority of cases—they simply indicate the absorption of some debris (septic intoxication). But if such an elevation of the pulse and temperature continues from day to day, or increases, it is very suggestive that infection

is present, especially if accompanied with constipation, headache, and a general feeling of ill being; and in celiotomies distention may be present. The sudden advent of a chill with rise in temperature and pulse toward the end of the first week is indicative of pus formation, possibly in the incision. Pain will be complained of previously in this locality. A careful record of these important signs must be made; days after their occurrence they may be the chief aid in the diagnosis of some abnormality that is taking place.

Respiration.—The respiration should receive careful attention during the period in which the patient is unconscious from the anesthetic. On account of the relaxation of the muscles of the neck the head falls forward on the chest and obstructs the larynx, so that it will be necessary for the nurse to elevate the lower jaw and pull it forward, maintaining it in this position until the effect of the drug has subsided. Again, the character of the respiration is frequently indicative of the patient's general condition. The deep and regular breathing which accompanies a pulse returning to its normal rate and a temperature approaching the correct body-heat, is in striking contrast with the shallow, sighing respiration which is a companion symptom of the rapid, flickering pulse, and dropping temperature of a patient suffering from shock or hemorrhage. A sudden acceleration of respiration accompanied with a rise in temperature and pulse rate in a patient apparently convalescing is very suggestive of a pneumonia developing. After operations within the cranium, when everything has been progressing favorably, stertorous (snoring) respiration is frequently the first symptom that attracts attention to the patient, and on investigation the other signs of cerebral compression are noted.

Water and Nourishment.—*Water* may be administered by the mouth after surgical operations as soon as nausea and vomiting have subsided, followed sooner or later by a liquid diet.

In *celiotomies* there are two divisions of thought regarding the proper time for the administration of water and other liquids. Some surgeons insist that water be given the patient as in operations in other regions *after nausea and vomiting have ceased* (excepting in operations on the stomach), claiming this is necessitated by the following existing conditions:

(1) The thirst that follows abdominal operations.

(2) The diminution of the watery elements of the blood produced by the anesthetic (ether or chloroform).

(3) The loss of animal fluids which may have taken place during the operation—that is from the loss of blood, vomiting, etc.

(4) The irritating effects of the anesthetic (ether or chloroform) on the kidneys, which are in many cases laboring under the disadvantage of some general infection.

These surgeons claim the following advantages for the early administration of water and other fluids:

(1) Thirst is relieved.

(2) The blood compensated for the watery elements lost.

(3) The kidneys are flushed and assisted in their function of elimination.

Other surgeons concede these facts, but insist that the time for the administration of water and fluids by the *mouth is the day previous to the operation;* or by proctoclysis after operative interference. They anticipate the condition the patient will be in after the operation, and prepare for it accordingly. These operators object to the administration of water by the mouth immediately after nausea and vomiting have ceased on the following grounds:

(1) The presence of fluids in the stomach causes *increased peristalsis* of the entire alimentary canal.

(2) *Peristalsis increases the peritoneal current,* the very thing which is not desired.

(3) *Peristalsis disseminates infection,* if this should be present, and transforms a local into a general infection.

(4) The first principle in the treatment of infection, and the basic idea to *prevent it, is rest.* Why then increase intestinal action when infection may be present by the administration of fluids by the mouth?

(5) Being unable to determine in many cases whether or not infection is present, the surgeon should treat such cases for the first twenty-four hours as *though it were.* Preventive measures are ideal.

(6) By the use of Murphy's system of proctoclysis all the fluid the system needs can be supplied, and with the *minimum amount of peristalsis.*

It is a very simple problem. An inflammatory process (infection) in one part of the body should be treated exactly as in another. The kind of tissue involved does not change the treatment. An infected joint is put at rest, or an injured articulation which *may become* infected is immobilized. So it is with the peritoneum; if infection is present *it is kept practically quiet* by administering *nothing by the mouth,* and inasmuch as operative measures may cause this serous tissue *to become infected* the same line of treatment is instituted. Careful observation of hundreds of cases have demonstrated that patients who have received water by the mouth immediately after vomiting ceased, *do not excrete any more urine* than patients who had received a thorough preparation *and who had been denied water for the first twenty-four hours.* The average amount in both cases is one pint. If *proctoclysis* is utilized intermittently during the period in which water is prohibited by

the mouth—the amount of urine is increased far above the normal. (See lecture on "Preparation of Patient for Operation," section "Water," also lecture on "Transfusion—Infusion," section "Proctoclysis.")

The appropriate length of time to maintain gastro-intestinal rest, in other words, the period in which nothing should be given by the mouth, *depends on the conditions which have been encountered within the abdominal cavity and the general constitutional symptoms which are manifested for the first day or two after operative interference. The rule being, the more severe the infection, the longer should be the period of total abstinence from liquids by the mouth, and vice versa, in uncomplicated and noninfected cases the time limit is shortened.*

Thus if during an operation *a local infection is encountered, or a tendency to a general peritonitis observed, fluids by the usual channel* are denied the patient for *forty-eight hours and occasionally three days,* depending upon the constitutional signs which develop. During this period, intermittent proctoclysis is administered. Then water and liquid nourishment are given for three days, beginning with an ounce hourly, and gradually increasing the amount until at the end of the second day the patient is getting all the fluids desired.

If *no unfavorable symptoms* are noted when fluids are first administered the indications are that Nature has been able to cope with the infection. A soft diet is now substituted for about three days; at the expiration of this time regular meals may be given, which as a rule will be about the eighth or ninth day.

If when fluids are first administered there is observed an increased distention of the abdomen, pain, eructations of gas, and possibly vomiting, accompanied with an increased pulse and elevated temperature, all liquids by the mouth are stopped for twenty-four hours and rectal infusion again utilized. These signs are prima facie evidence that the increased peristalsis caused by the liquid nourishment is disseminating the infection within the peritoneal cavity, and Nature has been unable to overcome it (or in exceptional cases some obstruction of the bowel may be present), so that it would be extremely injudicious to continue giving fluids to further extend the infection. After a period of twenty-four hours liquids may be again resorted to in the same gradual manner as described above, for three or four days, followed by a soft diet, until at the end of the tenth or eleventh day a regular dietary is being administered.

In uncomplicated and non-infected cases, the same line of treatment is carried out, the only difference being the *period of gastro-intestinal rest is shortened twenty-four* hours. Soft diet may be resorted to earlier and the regular dietary resumed at the end of a week. There is no question that

liquid nourishment induces abdominal distention, consequently a soft diet should be resorted to as soon as expedient.

No fixed rule can be given as to when liquids may give place to a soft diet, or this latter be replaced by regular meals. Each individual case is a rule unto itself. The point to be emphasized is, *the greater the degree of infection encountered, the longer should be the period of gastro-intestinal rest, and the manner in which the patient receives the first administration of fluids is the indication as to whether further rest is necessary or not.*

During the period in which gastro-intestinal rest is maintained by prohibiting fluids of any kind by the mouth, water is administered by Murphy's system of proctoclysis. In this way large volumes are absorbed, the system flushed, and the kidneys (the great excretory organs of the body) stimulated to their full capacity. (See lecture on "Transfusion—Infusion," section "Proctoclysis.")

In operations on the *vagina* and *rectum* (where it is desired to afford the latter organ rest for several days after surgical interference), and the different forms of *hernia* (where the effort to evacuate the bowel may prove disastrous to the results of the operation), a liquid diet is maintained for six or seven days so as to leave as little residue in the bowel as possible, after which a soft diet is given for three or four days, followed by a regular menu.

In cranial operations a liquid diet is maintained for a like period.

In operations in other regions the liquid nourishment is maintained for twenty-four or forty-eight hours, followed by a soft diet for three or four days, at the end of which period a regular regime is established.

Diet List.—I have been surprised at the diversity of opinion among nurses in hospitals and private practice as to what articles they consider constitute a liquid diet, and what foods are placed in the soft-diet list. I cannot conceive why lamb chops and chicken should be placed in this latter menu, and yet in several instances these are given under this head. The fact is, the average surgeon has no idea when ordering a "soft diet" what his patient actually receives. I am satisfied if he knew such meats as I have mentioned were included he would be horrified. It is only another example of errors creeping in the routine of hospitals and private practice, unless the strictest supervision is maintained. The chief of staff of any hospital, especially those having a training school for nurses, has no sinecural task, the details of which all tend toward a high standard of education. A nurse who is allowed to give chicken and lamb chops as articles of soft diet in her training-school course, follows the same regime in private practice. If she

becomes a head nurse of another hospital the same error is disseminated in that institution, and so on ad infinitum.

Uncooked egg albumen should form one of the chief ingredients in a liquid diet. It is easily digested, and being tasteless the patient does not tire of it. It can be made to form an ingredient in so many drinks that it certainly should hold an important place in this class of food. In my lecture on the "Preparation of the Patient for Operation," when speaking of the *preparatory diet,* I mentioned that if a stated amount of egg albumen were placed in the different broths a nutritive value would be given them, which otherwise are useless from the standpoint of nutrition. I also referred to the best way of preparing this substance. It may be added to lemonade, orangeade, and *other fruit juices* with water, frozen or otherwise. It is a common thing to witness nurses giving patients albumen lemonade day after day; instead of changing the flavor of the drink, they seem to forget that the taste needs diversity to tempt the appetite.

The diet list as used at Dr. Howard Kelly's private sanatorium certainly is the best that has come under my observation. With his permission I append it—

Liquid Food:

Milk—Plain, peptonized, malted; with albumen, with fruit juices, and koumiss. Buttermilk is one of the best articles in the dietary.

Wines—Grape juice (unfermented), wine whey, and in exceptional cases, a little whiskey if the patient is not doing well.

Broths—Beef tea, beef broth, broiled beef juice, chicken broth, oyster broth, clam broth, somatose.

Soups—Mock bisque, tomato, cream of rice, cream of asparagus, cream of pea, consomme, bouillon, and chicken soup with rice.

Soft Food:

Eggs—Poached, shirred, and soft-boiled.

Jellies—Wine, orange, or coffee jelly.

Creams—Apple float; whipped, orange or Spanish cream; cream of tapioca, cream of rice, baked custards in cups, boiled custard with float, tapioca with baked apples, arrowroot blancmange, orange sherbet, lemon sherbet, junket (plain or made with wine) panade.

Special Diets:

Oysters and Sweetbreads—Creamed oysters, broiled oysters, oysters on the half shell, creamed sweetbreads, broiled sweetbreads.

Eggs—Poached, shirred, and soft boiled.

Beef—Scraped beef sandwiches.

Birds—Partridges (broiled or roasted), broiled squab, chicken stewed with rice.

Porridge—Wheat flakes, oatmeal (strained), and other cereals, such as cream of wheat.

I cannot however agree to the use of milk *immediately before* and *after abdominal operations* because it is seldom thoroughly digested, as the common occurrence of curds in the stools demonstrate. The undigested particles form most excellent culture-media for the colon bacillus, and hence it is one of the greatest factors in the production of flatus, which is the surgeon's bete noire during manipulations in the abdomen, and after surgical interference it adds great discomfort to the patient. On the other hand when *the abdominal cavity is not the field for operative attack,* if the digestive system is in a normal condition milk is an excellent article in the dietary of the patient. Its diuretic qualities are not to be underestimated, while the many ways it can be utilized render it a factor in feeding the surgically sick. However, five or six days after celiotomies when flatus and its accompanying distention have ceased to irritate the patient, milk and its different preparations may be administered.

Nutrient Enemata—Rectal Feeding.—The practice of feeding patients by way of the rectum dates back to the earliest times in medicine; the ancients seem to have recognized the necessity for gastro-intestinal rest. The two questions that have always been uppermost in the mind of the physician are:

(1) Is the rectum capable of sufficient absorption to maintain the economy's equilibrium for a limited period?

(2) What articles of nutrition are best absorbed by the rectum?

For years it has been taught that albumen in its many forms was one of the easiest substances absorbed by the lower bowel, and for this reason it should be the chief ingredient in all rectal feeding; that fats were very difficult of absorption, and hence should be omitted in nutrient enemata; so that, even in books published within the past year, the yolks of eggs which contain a large amount of fats were considered inappropriate as an article of dietary when the rectum was to be used as the avenue through which nutrition was to be supplied.

In the numerous formulae for rectal feeding which I have found in hospitals and books, few if any mention carbohydrates. More attention has been given to this form of feeding in the last few years than formerly, principally because of the necessity for rest in our modern methods of treat-

ing gastric ulcers, etc. Scientific investigations have demonstrated the following conclusions:

(1) That albumen is poorly absorbed in the rectum even when predigested.

(2) The addition of salt assists *to some extent* the absorption of albumen.

(3) The absorption of fats is *greater than was formerly supposed,* although the capacity for absorption varies in individuals. It is best administered in an emulsified form or in the natural condition as found in the yolks of eggs.

(4) The use of sugar (carbohydrates) *is recommended,* the absorption of which seems to vary with the capacity of the individual.

(5) The rectum is capable of affording about one-quarter of the nourishment required to maintain the economy's equilibrium *under the best conditions.* The amount given at each feeding should be from eight to ten ounces, which is preferable to the smaller amounts (four to six ounces) formerly used, for the following reasons:

(a) Longer intervals between injections affording rectal rest.

(b) A larger water absorption.

(c) A longer period of gastric rest, for *it must be remembered when nutrient enemata are introduced into the rectum they excite gastric secretion.*

The following formulae may be used:

No. 1.

Yolks of two eggs.
Pure dextrose (grape sugar)............. ℥ 1
Common salt.............................grs. 8
Pancreatized milk........................ ℥ 10

Mix. Inject into the rectum slowly.—Drs. F. D. Boyd and J. Robertson.

As a substitute for the milk in the above formula, I prefer—

Liquid peptonoids........................ ℥ 2
Normal saline solution.................... ℥ 10

No. 2.

One whole egg.
Chlorid of sodium.......................grs. 15
Peptonized milk.......................... ℥ 10
Brandy or whiskey........................ ℥ ½

Mix. Inject slowly.—Mrs. Harriet Fenzel, Superintendent of Nurses, Protestant Hospital.

All enemata are administered at a temperature of 110°F. and will be about body-heat when received in the bowel. Alcoholic stimulants may be added to any formula when considered necessary.

The Administration of Nutrient Enemata.—One of the most frequent duties in which a nurse fails to accomplish the desired end is the administration of nutrition by way of the rectum. This is because of two factors—

(1) The nutritive material as a rule is not bland, but frequently irritating, and especially is this true when alcoholic stimulants are added.

(2) The nurse is unacquainted with the physiologic principles and the law of physics which govern the administration of fluids by this avenue, *the details of which have been set forth in the lecture on* "Transfusion—Infusion," section "Proctoclysis."

Nurse's Duties.—

(1) Cleanse the rectum of all fecal material by the injection of warm saline solution.

(2) Prepare a reservoir as for proctoclysis and equipped in a similar manner.

(3) Place the nutrient mixture in the reservoir at a temperature of 110°F. and maintain it at that point.

(4) Lubricate the rectal nozzle with vaselin, never with glycerin, as it causes an expulsive effort on the part of the rectum. *Suspend the reservoir from four to six inches above the plane of the rectum.* Insert the nozzle after allowing all air to be expelled by the fluid.

Under no circumstances should a hard-rubber piston syringe be used, nor a reservoir suspended at a height greater than six inches; in many cases it should be less, because the force exercised in both cases excites bowel spasm. I am indebted to my friend Doctor John Dudley Dunham for calling my attention to an article written by Drs. Francis B. Boyd and Jean Robertson of Edinburgh, Scotland, on the subject of "Rectal Alimentation"; also an essay written on the same subject and delivered before the Ohio State Medical Society by him. From these two articles the foregoing deductions have been made.

Bladder—Catheterization—Urine.—After some surgical operations it is necessary to catheterize the patient, as in operations on the female genitalia, such as the repair of the perineum, where a dry field is necessary to obtain the best results from the plastic work which has been performed. In such cases catheterization is resorted to every eight hours for four or five days. In other instances, either through a reflex action as in operations on the rectum, or from a paresis (partial paralysis) of the muscular walls of the bladder due to manipulations within the abdominal cavity such as the separa-

tion of adhesions between the urinary viscus and other organs, the bladder is unable to empty itself and catheterization is resorted to until the muscles have regained their normal tone.

This artificial means of emptying the bladder is by no means void of complications: I can think of no other procedure which is more liable to produce infection. Many patients leave our hospitals cured of the ailment for which they were operated on, but having a legacy in the form of a cystitis which in many instances causes as much distress as their primary disease. Cystitis as the result of catheterization in the large majority of cases is due to carelessness on the part of the nurse,—slovenly technic, which is as reprehensible as any one error a nurse can commit.

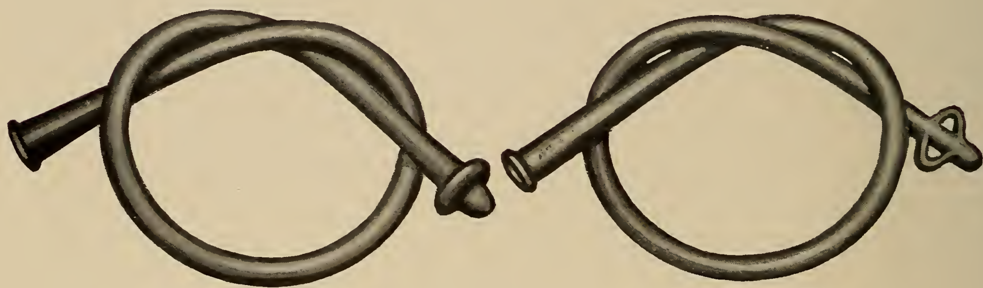

ILLUSTRATION LIV

Self-retaining Catheters.—The so-called "mushroom tip"

Before catheterization is attempted the parts around the urethra should be thoroughly cleansed with a warm saturated solution of boracic acid, or what I prefer, a solution of biniodid of mercury 1:5000. This variety of mercury is preferable to the corrosive sublimate, being non-irritating and five times as germicidal. The surrounding area should be protected by sterile towels, the catheter boiled and lubricated with some aseptic demulcent, the nurse's hands cleansed, and sterile gloves used.

Catheterization should be resorted to as seldom as possible. In those cases in which the bladder refuses to empty itself, whether from a reflex spasm, or a paresis the result of operative interference, it is frequently good policy after the bladder is emptied to allow the catheter to remain in place and repeatedly fill and empty the viscus with hot boracic-acid solution. The walls of the bladder in this way are stimulated to contraction, besides which the slightly antiseptic solution cleanses this portion of the urinary tract. If

the condition of the patient warrants, the internal administration of some diuretic will be ordered by the surgeon.

It is frequently necessary to leave a catheter in the urethra following operations on this canal, bladder, or prostate, to act both as a drain and as a means through which to irrigate. This form of catheter is so constructed as to mechanically retain itself in position, hence it is known as a *retention, or self-retaining catheter.* (See illustration LIV.)

Urine.—It should be a rule to send a specimen of urine to the clinical laboratory on the third or fourth day after all operations, and sooner if *there exists a deficiency in the amount of urinary excretion.* The report of the same is annexed to the chart. This is especially necessary in cases which have been operated on for an acute infection. The functionating capacity of the kidneys at all times is one of the conservation processes of the economy, and especially is this true following surgical procedures. The surgeon should therefore know if the work of these important organs is being carried out during this period. Negligence along this line has been the cause of deaths. The daily memoranda probably indicate the deficiency of urinary excretion, but no notice is taken of the same until complete suppression occurs; then active steps are taken to rectify this oversight. It is just as essential to examine a patient's urine after an operation as before. Again, if a *summary* is kept on the memoranda-sheet of the *total amount of urine excreted per day* it indicates instantly the amount of work accomplished by these important organs. (See lecture on "Ward Service," section "Clinical Charts and Sickroom Memoranda.")

Bowels—Cathartics.—At the present time laxatives are not given the day *following abdominal operations* as was formerly the custom, but a mild cathartic is generally administered about the third or fourth day, providing the bowels have not acted of their own accord. In other words, *this step is taken after the effects produced by a liquid nourishment on the patient are known, and before a soft diet is begun.* Calomel is generally employed, usually gr. 1/4 for six or eight doses, to be followed the next morning with a tumbler of solution of citrate of magnesia. If after a few hours following the administration of the saline no evacuations have occurred, a soapsuds enema is usually ordered. Should this produce negative results, the surgeon will possibly wait until the following day and repeat the cathartic. The frequent repetition of enemata alarms patients, through fear of some intestinal obstruction, besides which there is certainly no immediate necessity to evacuate the bowel—*in fact the use of cathartics following abdominal operations has been abused.*

In operations on the cranium laxatives are begun about the second or third day, the same cathartic utilized as for celiotomies. Enemata are espe-

cially indicated to mechanically soften the first stool and assist in an easy evacuation. I mention this advisedly, as in a cranial operation occurring in my practice where great effort in straining was made, venous oozing occurred sufficient to moisten the dressings.

It is certainly conservative to prevent an evacuation of the bowel for *at least four or five days following operations on the vagina* (such as the repair of the perineum), or in *operations on the rectum* (as in cases of fistulae) where the sphincter ani has been severed. There is a great diversity of opinion among authorities as to the proper time for the administration of cathartics under such circumstances, some advising their use twenty-four hours after the operation, while others desire ten days to elapse. As a rule the salines are chosen because of the thin watery stool they produce. Immediately before the cathartic is about to act an enema of soapsuds is administered which is retained as long as possible to soften any hard fecal mass that may be present. The patient should be admonished that no extra exertion at straining should be made.

In surgical interference in *other portions* of the body these remedies are administered according to the exigencies of the case. *After emergency operations* (excepting in accidents within the abdomen when intestinal rest is necessary) the surgeon probably will order a cathartic as soon as possible because the patient has received no preparatory treatment. The intestinal tract is foul; the circulation is in consequence impeded, and the functions of the economy cannot be carried on to a normal standard. Frequently, a brisk cathartic will also stimulate a free urinary excretion.

Operative Wound, Dressings, and Sutures.—A clean wound which has been aseptically dressed and *without drainage* as a rule requires no attention. The generous amount of primary dressings necessary to absorb any oozing which may occur for the first day or two, and to serve as a soft cushion for the newly cut part; or, as in abdominal operations, to lessen the jar and support the abdominal wall during the stage of vomiting, the surgeon will order changed for lighter dressings possibly at the end of the first week. If however, *drainage was used,* your orders in all probability will be to remove the same within twenty-four or forty-eight hours. In abdominal operations the heavy scultetus bandage if it has been employed should be laid aside at the end of a week; six- or eight-ply gauze (12 by 12) held in place by strips of adhesive plaster are more comfortable.

If toward the latter part of the first week there is an increase of pulse and temperature the wound should be inspected. If infection is found to be present such sutures will be ordered removed as afford the best drainage, at the same time bridges of adhesive plaster are used to prevent excessive

gaping of the incision. From this time on the wound will be treated as an infected one. (See lecture on "Wounds.")

Sutures.—If no infection has occurred in the wound the sutures are allowed to remain in place until the eighth or tenth day when they are removed in the manner already described in the lecture on "Wounds." I shall again repeat the details *because of the careless manner in which this procedure is so frequently performed*—

Necessary Equipment.—

(1) 1 pair of sharp-pointed scissors and dissecting forceps (sterilized).

(2) Sterile glass of hydrogen dioxid.

(3) Alcohol or Harrington's solution.

(4) Sterile towels.

(5) Dressings.

(6) Wipe sponges.

(7) Gloves.

(8) Adhesive plaster.

Steps of Technic.—

(1) Remove bandage and dressings, *excepting the gauze adherent to the wound.*

(2) Cleanse hands.

(3) Adjust sterile towels around field to prevent contamination from clothing.

(4) Adjust dry sterile gloves.

(5) Moisten the gauze adherent to the wound with hydrogen dioxid until the crusts are thoroughly softened, and the gauze is loosened from the wound—no traction is permissible to remove the same.

(6) Saturate a piece of gauze with alcohol or Harrington's solution and lay over the stitches for one or two minutes.

(7) With the aid of dissecting forceps pull *one side of the stitch upward, cut the same as close to the skin as possible,* then remove the suture.

(8) Apply sterile gauze dressings, held in place with adhesive straps, to protect the stitch holes.

Patient's Toliet.—The gown the patient wore during the operation was removed in the surgery and a clean one substituted, so that it seldom will be necessary to pay any attention to this part of the toilet for the first twenty-four hours and possibly two days, depending on the physical condition of the patient, but it should be protected by towels draped over the

chest and around the neck of the patient in case vomiting ensues. The gown is changed every other day thereafter.

Tepid sponge baths (105° to 110°F.) are given about the third day, providing the case is progressing favorably, otherwise these baths will be postponed for a day or two. The use of alcohol rubs at night are in order after the first twenty-four hours. The hair is combed and braided. The finger nails manicured, and the teeth cleansed. In short, the patient's toilet should be as esthetic as the physical condition will permit. The bed linen should be changed every other day, unless existing conditions indicate otherwise. In these various steps looking toward the comfort of the patient, care should be exercised to prevent any unnecessary fatigue for the first few days after an operation. I have frequently seen the clumsy manipulations of a nurse so thoroughly exhaust patients that they would rather be left alone than submit to a fresh toilet, which under proper conditions should be a pleasure.

Period of Confinement to Bed.—There is no standard rule governing the length of time necessary for the patient to remain in bed after an operation. This of course varies with the nature of the surgical procedure, and the individual views of the surgeon. But this axiom should be borne in mind, *after convalescence is established, sunlight, fresh air, and exercise are more conducive to a normal restoration of health than prolonged confinement in bed.* The average patient suffers more or less from psychic impressions, the result of the operation,—*they are nervous.* The operation becomes an epoch in his or her life, and everything from then on is dated from that time. The hospital and surroundings serve to prolong these impressions, so that the term of hospital confinement should be as limited as the nature of the case will permit.

Abdominal Operations.—About the tenth day in *favorable cases* the surgeon will probably allow the patient to recline on a back-rest, with an admonition not to overtax the strength to the point of fatigue. Two days later the patient will be permitted to sit in a chair at intervals for a similar period. It is the nurse's duty to assist in these preliminary steps, and not permit any extra exertion on the part of the patient. About the fourteenth day the patient is allowed to walk around the room, and in a few days to return home.

In cases in which *complications have occurred* you can easily appreciate no definite time can be assigned for the patient to remain in bed.

Following celiotomies, it is the custom among *some surgeons* to have a semielastic abdominal supporter adjusted to the patient before they are permitted to walk, and which they are advised to use for two or three months. Personally I concur in the advisability of an abdominal supporter in all

cases, especially in obese patients with pendulous abdomens, whose abdominal walls are so weakened as to be considered nil. In any case the artificial support lessens the numerous jars which are severely felt in walking after abdominal operations, and I think it adds comfort to patients and gives them confidence in themselves; but I do not advise this support as a means of preventing a hernia occurring in the abdominal incision. If a proper technic is used in closing the wound and it heals by first intention, no hernia will develop; if infection occurs or the incision has been poorly coaptated, nothing will prevent a rupture.

After operations for *inguinal or femoral hernia* the patient should be kept in bed for three weeks providing no complications occur. This is necessitated on anatomical grounds.

Operations in Other Regions.—It is impossible to definitely give the time limit for a patient to remain in the recumbent position for the various operations occurring in the different regions of the body, but the same general principles are observed as have been given in abdominal operations. The strong, healthy, robust workman, or those of advanced age, who because of some accident or acute infection are forced to submit to an operation, will feel the effects of confinement quicker than the chronic invalid. Realizing this, the surgeon shortens the period of confinement to bed consistent with convalescence.

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LECTURE XXIII

SOME POSTOPERATIVE COMPLICATIONS

Surgical procedures are occasionally followed by complications which not only influence the immediate results of an operation but frequently leave their impressions indefinitely on the patient. Among such complications may be mentioned—

(1) Shock.
(2) Hemorrhage.
(3) Tympanites.
(4) Infection of operative wound.
(5) Peritonitis.
(6) Nephritis.
(7) Phlebitis.
(8) Thrombosis.
(9) Embolism.
(10) Septic intoxication.
(11) Septicemia.
(12) Pyemia.
(13) Pneumonia.
(14) Acute obstruction of the bowel.
(15) External fecal fistula.
(16) Erysipelas.
(17) Tetanus.

It must be distinctly understood that while these subjects are mentioned in this connection, they are by no means limited to this period, but frequently occur independent of operative procedures. The importance of Shock, Hemorrhage, and Nephritis, and their association with other surgical conditions, made it necessary to consider them in my earlier lectures.

Tympanites.—By this term is meant, the *distention of the abdomen due to an abnormal amount of gas within the intestine.* This condition is a frequent complication following abdominal operations. It varies in severity

from the simple type in which colicky pains are experienced and slight distention is noticed, to one in which the distention assumes enormous proportions and causes pressure on the thoracic organs as manifested by a rapid pulse and shallow and increased respiration.

Causes.—

(1) A paresis or partial paralysis of the intestine, superinduced by manipulations within the abdomen such as the handling of the viscera.

(2) Prolonged pressure from abdominal sponges, producing a similar paresis.

(3) A reflex condition caused by surgical operations on *certain organs* within the abdomen and pelvis.

(4) Excessive catharsis in the preparatory treatment.

(5) The psychic effect of an abdominal operation on highly neurotic patients, especially in those who have previously undergone a celiotomy.

(6) A strictly liquid diet undoubtedly increases the distention.

Symptoms.—Usually between the second and third day after an abdominal operation the patient complains of severe colicky pains through the abdomen, with possibly an inability to evacuate gas per rectum. The temperature and pulse at first are not increased. Vomiting is absent in a large majority of cases. The facial expression is normal. In rare instances distention becomes so marked as to seriously interfere with breathing and the action of the heart. The respirations are rapid and shallow, the pulse and temperature increased, and a facial anxiety developed. Vomiting is then not uncommon.

Treatment.—In ordinary forms of this complication a rectal enema similar to one of the following formulae should be administered by means of a colon tube introduced as far into the bowel as possible.

℞

Epsom Salts	℥	2
Glycerin	℥	4
Turpentine	ʒ	1
Water q. s.	pt.	1

Mix. Sig. Use as directed and repeat if necessary in two or three hours.

℞

Milk of asafetida	℥	4
Turpentine	ʒ	1
Rich soapsuds q. s.	pt.	1

Mix. Sig. Administer in same manner, and repeat if necessary.

In the exceptional cases of enormous distention the rectal catheter should be introduced as high in the bowel as possible and allowed to remain in position. This is best accomplished by the nurse inserting her finger in the rectum as a guide to the instrument. To facilitate this procedure some authorities advise the knee-chest posture, but this latter step would hardly be justifiable excepting possibly in the most severe forms of this trouble because of the short interval which has elapsed since the operation.

Locally hot turpentine stupes, consisting of several layers of flannel wrung out of the following mixture and placed on the abdomen, are ordered: Turpentine 1 ounce, hot water 4 pints. These layers of flannel should then be covered with rubber sheeting over which is placed several folds of dry flannel. These applications should be kept warm by frequent changes.

Internally the surgeon will order some brisk cathartic.

For years I have used the following combination *hypodermatically* with excellent results:

℞
Eserin salicylate........................gr. 1/40
Strychnin sulph.........................gr. 1/30

All food should be stopped; its presence in the alimentary canal does no good, but possibly harm by increasing the formation of gas and exciting vomiting.

Nurse's Duties.—

(1) Stop all nourishment and the administration of water immediately. By this means you will be acting conservatively until you ascertain the surgeon's views.

(2) Report to the surgeon or proper authority that distention of the abdomen is occurring; whether pain is present, its character and severity; the pulse rate; degree of temperature; facial expression, and the presence or absence of vomiting. The surgeon should be made cognizant of all details, especially in cases where severe infection has been encountered, or dense adhesions have been separated, because he is the only one in a position to judge whether the tympanites is due merely to a temporary paresis, or if there is a probability of peritonitis ensuing, or an obstruction of the bowel developing.

Infection of Operative Wound.—This complication generally occurs about the end of the first week after operative interference.

Symptoms.—A slight elevation of temperature will be noticed, possibly chilly sensations, and a complaint of pain in the wound; or at times these

symptoms will be absent and the infection remain unnoticed until the first dressings are removed.

Causes.—

(1) Improperly prepared field of operation.

(2) Lack of care in the protection of the field during the operative procedures.

(3) Mangling of the tissues by carelessly applied hemostats, or bruising the edges of the wound by too forcible application of the retractors.

(4) Debris left in the wound, such as blood-clots and devitalized tissue.

(5) Excessive tension of the coaptating sutures, in this way interfering with the circulation.

(6) The penetration of the staphylococcus which inhabits the superficial layers of the skin to the deeper subcutaneous tissues by way of the suture hole.

Infection of the operative wound is a complication every surgeon regrets, because convalescence is prolonged and scar tissue is increased. In abdominal cases the process of suppuration may extend to such a depth as to weaken the underlying structures and thus cause a hernia to form; or in operations for hernia the same complication may nullify the surgical procedure. While in operations on the extremities the scar tissue left by the wound having become infected may entangle nerve filaments in its meshes and cause constant suffering, or the suppurative process may be so extensive as to necessitate reamputation.

Occasionally the entire wound does not suppurate, but owing to some unabsorbed buried suture, or some diseased condition of the bone, or some infection at a remote point, the pus burrows from the deeper tissues and discharges externally through the wound. A channel or sinus is thus formed which is known as a *suppurative sinus.*

Treatment.—This is the same as has been given for infected wounds in the lecture on that subject.

Nurse's Duties.—These are also similar.

General Remarks on the Peritoneum.—The peritoneum is a serous membrane which lines the abdominal cavity, and is reflected on the organs located within. Some of these are completely clothed by it, others partially. It can be easily understood that cavities, fossae, gutters, and grooves are formed during the process this membrane takes to cover the numerous organs, all of which have a bearing from a surgical standpoint. The surface measurement of the peritoneum is about equivalent to the area of the skin.

It is very richly supplied with blood-vessels, probably more so than any other tissue in the body, these ranging in size from some of the largest in

the economy to the smallest twigs that are found in the vascular system. This has an important bearing on the surgical mind. It signifies that Nature has endowed this thin, delicate membrane with facilities to protect itself, so that the peritoneum which was formerly considered exceedingly susceptible to infection is now known to possess the greatest resisting power of any tissue in the body, and fortunately it is so, for no tissue receives such abuses and insults as does the peritoneum.

This serous tissue has several functions to perform. It absorbs and secretes fluids. By its smooth and moist surface it allows free movement of the numerous abdominal or pelvic viscera without friction. It possesses an inherent quality to adhere when two surfaces are *brought in contact under pressure, or to form adhesions when inflamed.* In this way repair of peritoneal wounds are consummated and inflammatory conditions checked. It is this membrane which assists in the peritoneal-current I have so frequently mentioned. It is this tissue which drains the peritoneal cavity. *Few lymphatics are found in the lower abdomen and pelvis as compared to the numerous absorbents which are encountered in the upper abdomen beneath the diaphragm,* a fact of great importance from a practical standpoint.

From this anatomical knowledge it can readily be appreciated why infections occurring in the pelvis are not as serious as those developing in the higher zones of the abdomen, and the reason for the use of Fowler's position after all abdominal operations—because it affords postural drainage toward the pelvis, a harbor of comparative safety.

Peritonitis.—*This is an inflammation of the peritoneum.* I shall not attempt to describe the various classifications which have been made, but will only speak of *septic peritonitis.*

Causes.—This complication is always due to the presence of pathogenic bacteria. Their entrance into the peritoneal cavity may occur through various channels, among which may be mentioned—

(1) An infection following appendicitis.

(2) Ulceration of the gall-bladder, stomach, or intestines, accompanied with leakage into this serous cavity.

(3) The rupture of a pus tube or pelvic abscess.

(4) An infection from the uterine canal.

(5) The final results of septicemia or pyemia.

(6) Gangrene of the bowel from obstruction or embolus.

(7) Any injury within the abdomen of sufficient severity to lower the resisting power of the part and permit of the propagation of pathogenic bacteria.

(8) The introduction into the peritoneal cavity of microörganisms, the result of faulty technic, such as the use of non-sterile instruments, infectious sponges, or any break in the chain of asepsis.

Symptoms.—The initial symptoms will depend on two of three factors—(1) The virulence of the pathogenic organisms or (2) the number of the invading bacteria, and (3) the amount of resisting power the economy can develop.

If peritonitis develops from a sudden rupture of a gangrenous appendix, or the erosion of an ulcer through the intestines as in typhoid fever, or the bursting of an acute pus tube, or a leaking gall-bladder due to ulcerative processes occurring through its walls, the symptoms will be *profound from the first.* The devastation will be so great that Nature cannot muster her powers of resistance, but if such a pus tube ruptured during a surgical operation, or an intestine was injured sufficiently to spill its contents, or a similar accident happened to an appendix or gall-bladder, the precautions which were taken during the operation—such as the careful placing of sponges around the focus of infection to prevent soiling the peritoneum—would prevent to a very great exent the crushing down of the economy by the bacteria present in the infectious material. Nature would have an opportunity under these conditions to develop a resistance against the invading infection, and hence the symptoms would not be as profound, but develop more gradually. This latter will be the condition met with in a large majority of cases of peritonitis occurring after abdominal operations.

Usually between the third and fourth day after a celiotomy *distention of the abdomen* will be noticed, which may at first be mistaken for ordinary tympanites. Sooner or later the patient complains of *rigors,* or possibly a decided *chill* followed by an increase of *temperature,* which varies decidedly in different cases. In some the mercury will reach 101°, while in others 104° or 105°F. will be recorded. The *pulse* will vary in proportion to the temperature. The *respirations* increase; *pain* is present and is of a paroxysmal character, subsiding at intervals only to return with great severity. Every movement of the patient aggravates this symptom; examination of the abdomen, however carefully made, serves to increase the suffering. *Vomiting* is an early symptom; at first, the contents of the stomach, which is followed by bilious emesis; and retching, which accomplishes nothing excepting that it adds to the pain. *Thirst* now develops; the patient begs for water only to immediately vomit it. The *respirations* become more shallow as the pain increases, because an endeavor is made to prevent the diaphragm descending to such an extent as to produce undue pressure on the organs below. The *position* assumed in bed is characteristic, the legs are flexed on the thighs, the thighs partially so on the abdomen; the patient demands more

pillows placed under the shoulders to relieve the tension of the abdominal muscles, or lies on the side coiled in a position to accomplish the same object. *Constipation* is present. The *urine* is scanty. If the natural resisting forces of the body and the mechanical obstructions which Nature has thrown out in the way of adhesions, together with the assistance of such treatment as is instituted, are capable of overcoming the infection, these symptoms gradually subside. But if the case is progressive, the temperature climbs higher, the pulse becomes faster and more feeble, the respirations more shallow because of increased pain and aggravated distention. Vomiting becomes incessant, which together with the great amount of toxemia present, only adds to the exhaustion and finally produces collapse. The *facial expression* during this progressive stage is one of grave anxiety; the angles of the mouth are drawn, the nose is pinched, the eyes deep set, the skin assumes an ashy hue, while beads of perspiration moisten the entire surface,—the picture being complete of what is known as the "Hippocratic countenance," a symptom of impending dissolution. These are the common signs of a general septic peritonitis. There are wide variations from the above classic symptoms; some so virulent from the very onset as to overwhelm the patient in twenty-four hours, while others run a course of a week or ten days with only a moderate elevation of temperature, and little or no distention or pain; in fact, the classic symptoms are practically absent. Again occasionally the first sign noticed is a slight delirium occurring at night, generally at the time the usual symptoms first manifest themselves, that is about the third or fourth day, followed by the train of symptoms I have endeavored to depict.

Prophylaxis (preventive treatment) is the ideal. It is our duty to carry out such details as will safeguard the patient from one of the most fatal diseases in abdominal surgery. This prophylaxis should include—

(1) As thorough a preparation of the patient as *time and the exigencies of the case will permit.*

(2) Constant care in the preparation and sterilization of such articles and instruments as are used during the operation.

(3) The *maintaining of a complete sterility during the operation,* by discarding all instruments, sponges, etc., *which have become infectious.*

(4) The judicious use of abdominal sponges around an infected area to prevent contamination of the general peritoneal cavity.

(5) The wearing of such rubber gloves as are not damaged, however clean the hands are *supposed to be.*

(6) The utilizing of the Fowler position *from one to three days after all celiotomies* and the employment of this same position *before* and *during operative interference in fulminating cases.*

(7) The maintaining of gastro-intestinal rest.

In these preventive measures I have mentioned, some concern the nurse exclusively, others both surgeon and nurse. For instance, the preparation of the patient, the sterilization of sponges, instruments, dressings, etc., come within the province of the nurse; while the position the patient assumes in bed after an operation, and whether or not gastro-intestinal rest is to be instituted, will depend upon the judgment of the surgeon. It is, however, quite proper for the supervising nurse of the floor (in the absence of other authority) when a patient is admitted to the hospital suffering from some acute fulminating abdominal infection, to order such patient placed in the Fowler position immediately, and to withdraw all fluids and nourishment by the mouth until *specific orders are obtained from the attending surgeon or proper authority.* In this way she is safeguarding the interests of the patient, and in no way trespassing on the prerogatives of the surgeon. In fact, there is as much justification in this procedure as there is for a nurse to control an emergency hemorrhage of an extremity by a tourniquet.

Treatment.—This will of course depend on the origin of the infection. If the peritonitis is the result of a leaking appendix, perforation of a gastric ulcer, or ulceration of the intestine the result of typhoid fever, or from some accident which produces similar consequences, *immediate operative interference* is indicated, looking toward the removal of the causative factor. Under such circumstances *no extensive preparation is permissible.* The *after-treatment* will consist of gastro-intestinal rest, the Fowler position, and proctoclysis.

Septic peritonitis developing after a celiotomy is another problem. Some surgeons advise a generous cathartic of calomel and salines immediately the first signs develop. If in spite of this treatment the symptoms are progressive these operators reopen the abdomen in an endeavor to discover the point of infection and cleanse it, thus reducing the base of supply. Another class of surgeons go a step further after carrying out the above technic and advise the irrigation of the abdominal cavity with large quantities of saline solution in the hopes of diminishing the amount of infectious material present. This is followed by free drainage.

On the other hand, conservative surgeons oppose such radical technic. In their opinion *rest is the sheet anchor from which to expect favorable results.* Cathartics are prohibited because by their use exaggerated peristalsis is developed,—a factor in the dissemination of infection. Their argument is: why should cathartics *be used after operative* interference when a septic peritonitis is developing, if the same is contraindicated as an *anteoperative* measure in the presence of an acute local peritonitis through fear of disturbing adhesions and favoring the spread of infection?

The reopening of the abdomen is censured on similar grounds. The breaking up of adhesions in an endeavor to locate the point of infection only

serves to throw down the barricade which Nature has established to circumscribe the infectious material, thus allowing fresh fields to become infected and permitting the inflammatory wave to extend unchecked. Furthermore, these operators argue, the depressing effects of the second anesthetic should be taken into consideration; that shock is invited by handling the intestines, especially in a patient whose resisting power is already below par; that from an anatomical standpoint it is impossible to cleanse the abdomen, however thoroughly the work is done; that irrigation of the peritoneal cavity with a saline solution is only another means of disseminating infection, and that when all these facts are added together and statistics gathered of secondary operations for general septic peritonitis, the death rate is increased, not diminished.

These operators rely on postural drainage as obtained by the Fowler position; gastro-intestinal rest to favor the formation of adhesions; rectal feeding as a means of supplying nourishment; the Murphy proctoclysis as a cardiac stimulant, a diluent of toxic material within the circulation, and as a mechanical means to increase the urinary excretion, thus ridding the economy of septic material (see lecture on "Transfusion—Infusion," section "Proctoclysis"); morphin administered hypodermatically in the minimum dose to control pain and add further rest. Possibly hot turpentine stupes applied over the abdomen and frequently changed may be utilized (for the proper preparation of which see section "Tympanites" in this lecture).

Phlebitis—Thrombosis—Embolism.—Before taking up the discussion of these topics it may not be out of order to remind you that the inner coat of blood-vessels is clothed with a delicate lining composed of endothelial cells, the functions of which are the following:

(1) To reduce to a minimum the amount of resistance caused by the blood-current through the vessels. In other words, it forms an antifriction surface.

(2) To prevent the coagulation of the blood.

(3) To aid in the process of repair of injured blood-vessels. (See lecture on "Blood-vessels," section "Histology.")

With these facts in mind, I desire to call your attention to the more common diseases occurring in the vascular system.

Phlebitis.—By this term is understood an *inflammation of a vein.* This condition is occasionally seen after operations and produces a very undesirable complication. Its presence is practically always associated with a *thrombus* or clot in the vein, which is inflamed. Hence, the term *thrombo-phlebitis* conveys to the mind an *inflammation of a vein in which a blood-clot has formed,* partially or completely occluding the vessel. Phlebitis is a much

more common disease than its relative *acute arteritis, which is an inflammation of an artery.*

Causes.—Phlebitis may be developed from the following factors:

(1) *The direct entrance of pathogenic bacteria through the walls of the vessel as the result of a local infection.*

(2) A general toxemia, the result of such diseases as scarlet fever, diphtheria, typhoid fever, pneumonia, rheumatism, and *the different forms of septic infection such as septicemia, pyemia, etc.*

(3) Occasionally a phlebitis develops after an operation for which no cause can be assigned.

Symptoms.—Pain and tenderness in the line of the vein; a mottled or marble-like appearance of the skin; edematous swelling if an important vein is occluded, although this symptom is not always present. If the vein is superficial the course of the vessel can be distinctly felt, the feeling of which is tense and nodular. Should suppuration develop, in addition to these symptoms there will also be present those common to suppuration occurring in other tissues, viz., a sudden chill or occasional rigors, increased pulse rate and elevated temperature, loss of appetite, and digestive disturbances.

Final Results.—In the early part of this lecture, I mentioned that one of the functions of the endothelial lining of the inner coat was to *maintain the fluidity of the blood.* If therefore as a result of a toxemia or the direct invasion of bacteria, a phlebitis is produced, the endothelial lining becomes so damaged as to destroy this function and permits the blood to become coagulated or clotted,—a *thrombophlebitis* is the result. If the inflammation of the vein has been produced by the invasion of pus-producing organisms, such as the streptococcus or staphylococcus, the tendency is for suppuration to occur in the vein and thrombus (clot). Should this be the result the infectious particles are carried by the blood-stream to remote parts (these fragments are termed emboli), become lodged and form nuclei for the development of abscesses. Even the mildest form of thrombophlebitis gives the surgeon great concern. The majority of cases occurring in the lower extremities subside in a few weeks under proper treatment, by a collateral circulation being established. In some instances, however, edematous swelling and pain continue for an indefinite period, during which time the patient is forced to use some artificial support to the circulation, such as bandages, etc.

Treatment.—This consists of rest general and local, varying from days to weeks, and sometimes months; the application of cold or heat along the course of the vein during the acute stage; the encircling of the limb if that is the part affected with a carefully applied flannel bandage; the elevation

of the limb to assist venous return of blood. Massage or rubbing of the limb is *absolutely contraindicated. In this way the thrombus may be broken, the fragments float in the blood-current and thus become emboli,*—a very dangerous complication. If suppurative phlebitis develops, the case becomes one for operative interference, and the vein is dissected.

Constitutional treatment is directed toward the general condition of the patient and will be prescribed by the surgeon.

Thrombosis.—By this term is understood *the process by which the blood becomes clotted within a vessel or chamber of the heart. The clot or thrombus as it is called remains at the site of origin and occludes the vessel partially or completely.*

Causes.—A thrombus or clot may form as the result of a phlebitis as has been explained. In fact I should say a phlebitis is the most prolific cause. The mechanical effects produced by wounds, contusions, and varicose veins on the inner coat of the vessels may develop thrombosis. Acute infections, as have been mentioned as a causative factor in phlebitis, are responsible for the development of a thrombus, because such infections not only produce changes in the walls of the vessels but bring about alterations in the character of the blood.

Classification.—A thrombus is classified as (1) simple or aseptic, (2) infectious or septic—depending as to its cause; if a clot forms in a blood-vessel as the result of a wound or contusion the thrombus would be classed as simple, but if following in the course of some acute infectious disease it would be considered of the infectious variety.

Symptoms.—If the thrombus occurs in a superficial vessel and is associated with a phlebitis (which is true in a large majority of cases) the symptoms partake of that disease. If an artery is occluded, pulsation is absent below the point of obstruction. A thrombus occurring in the mesenteric vessels produces all the symptoms of an obstructed bowel (q. v.), to which may be added the escape of blood from the rectum,—a very diagnostic symptom. The occlusion of a pulmonary vessel by a thrombus manifests similar symptoms as are seen in pulmonary embolism, although not as rapid in development, and will be considered under that head.

Final Results.—*If the thrombus is aseptic* it may become organized and undergo the same changes as a clot that forms when a vessel is ligated, which process I have described in the section of "Repair of Wounds of Blood-vessels." (q. v.) Gangrene of the part supplied by the occluded vessel will be the result if a collateral circulation cannot be established. If the thrombus be of the *infectious* variety suppuration is liable to occur, and fragments of the thrombus are carried to remote parts. These migratory

fragments of the clot (emboli) may become the initial factors in the production of abscesses in remote organs and thus develop that condition known as pyemia.

Treatment.—If the thrombus occurs in an extremity and is of the *bland variety* the same line of treatment is instituted as for phlebitis. A thrombus occurring in the mesenteric vessels demands a surgical operation because a collateral circulation cannot be established and gangrene will be the result. *Infectious thrombi* when accessible demand prompt surgical intervention.

Embolism.—*This term indicates the occluding of a vessel by a foreign body or embolus which has been brought from some remote part.* Note the difference between an embolus and a thrombus. The latter is a stationary clot *which remains at the site of formation,* while the former is *a migratory body floating in the blood-current,* and eventually blocking a vessel.

Causes of Emboli.—The majority of emboli are derived from fragments of a thrombus, or an entire thrombus dislodged and carried in the blood-stream to some remote part. There are other substances which may enter into the formation of these migratory bodies, such as detached portions from the wall of a diseased blood-vessel, or a ragged fragment of the inner coat which has become separated by being roughly clamped during operative measures; particles of tumors which have eroded through the sides of vessels and thus entered the blood-stream; deposits from a diseased valve of the heart; fat globules; clumps or masses of bacteria, etc.

Classification.—The division made of thrombi is equally applicable to emboli, viz., (1) *simple or aseptic,* (2) *infectious or septic,* depending of course on the origin of the embolus.

Symptoms.—The general picture is the same as in thrombosis, excepting *the symptoms produced by an embolus appear more suddenly than those of a thrombus, because the circulation is interfered with immediately and not gradually.* For this reason also an embolus is a more dangerous complication than a thrombus, besides which, *being a migratory body,* it is liable to block the circulation of an important organ *remote from its point of formation.* If an embolus originates from a suppurating thrombus or masses of pyogenic bacteria another picture may develop. These migratory bodies deposit their infectious material in remote organs, produce suppuration at these points, and lay the foundation for that form of general infection known as *pyemia.*

The symptoms produced by an embolus when it blocks an *important vessel of the lung,* deserve special notice, because it is one of the causes of sudden death in postoperative cases, and frequently brings unjust criticism on both the surgeon and nurse. The symptoms are very profound, and appear without the slightest warning. A few hours previously, in fact a few

minutes before the onset, every indication may point to a satisfactory condition. After some slight movement the patient complains of severe pain around the heart, followed immediately by a sense of suffocation; air hunger develops; the face becomes ghastly and assumes an expression of anxiety which of itself is characteristic; the pulse which has been within normal range becomes faster and more feeble until it cannot be counted. Death may result instantaneously. Such a case occurred in a patient on whom I operated for the repair of the perineum. On the third day after the operation when making my usual visits in the hospital her pulse and temperature were normal; I assured her husband of her speedy recovery, and proceeded with my work. In a few minutes I was hastily summoned to the room, and was chagrined to see my patient dying. Another case which occurred in my practice followed a Cesarean section, the patient weighing 600 pounds. Her condition progressed normally until the eighth day, when in attempting to turn on her side to drink a glass of wine, she died suddenly, undoubtedly from a fat embolus. However, if only a small twig of a pulmonary vessel is occluded the symptoms will not be as severe. Difficult breathing, frequent coughing, and expectoration of blood are the signs usually present.

Treatment.—This is the same as recommended for thrombosis.

Septic Intoxication, Septicemia, and Pyemia.—As I have previously stated in one of my earlier lectures, *infection is the successful entrance and multiplication of bacteria in the economy*; that after such entrance has been accomplished these microörganisms eliminate toxins or poisons, capable of producing a similar infection to the bacteria from which they originated; that the constitutional effects of the microörganisms and their toxins is termed *toxemia* or blood-poisoning, while by the term *ptomain* is understood an alkaloidal poison produced by *putrefactive bacteria only.* Also when speaking of the principles of infection I divided the subject into *local* and *general. Local* when a limited area alone is affected by the presence of bacteria. *General* when the entire blood-current is contaminated. I now desire to give you the three principal divisions of general infection, viz., (1) septic intoxication, (2) septicemia, and (3) pyemia. It must be clearly borne in mind while I have seen fit to place the different forms of general infection as postoperative complications, they are by no means limited to that period; in fact, general infection probably follows in the wake of accidents oftener than as a sequence to operative measures.

Septic Intoxication Incorrectly Termed Sapremia.—*This is the general absorption of ptomains from putrefactive material, toxins from pyogenic bacteria, or both.* You will notice in the definition given the *microörganisms themselves are not absorbed,* simply their chemical products. It was formerly taught *only ptomains from putrefaction* were carried into the blood-

current; now it is conceded that *the presence of toxins from the pyogenic organisms are frequently, if not constantly present.* Putrefactive material which can produce septic intoxication is found in blood-clots which have become disorganized and retained in the uterus after labor, or in blood-clots and other fluids which have decomposed and become pocketed in a badly drained wound; in crushed and devitalized tissue left after surgical operations without any means of escape; and in ruptured pus sacs within the abdominal cavity, even though no living microörganisms are present.

The three essentials necessary therefore for the development of septic intoxication are:

(1) *Putrefactive material.*

(2) *Pockets or cavities containing such material, without an exit.*

(3) *Large absorbing surfaces.*

Symptoms.—The premonitory symptoms of septic intoxication are not distinct; I may say they are suggestive only, and consist of a dry tongue, headache, restlessness, high-colored and scanty urine, and a feeling of ill being. Sooner or later a severe chill, or chilly sensations are experienced, followed by a rapid rise in temperature which may reach 105°F., accompanied with a weak and fast pulse. My experience is the earlier the chill appears after an accident has been received, or surgical operation performed, the more suggestive is the case of septic intoxication. If the amount of putrefactive material absorbed is limited, or prompt drainage is immediately instituted, the symptoms subside in a day or two. In the severe forms where a large dose of ptomains or toxins have been absorbed the exhaustion from the beginning is pronounced, delirium is present, and the patient is overwhelmed with an aggravation of all the symptoms I have described.

The Final Results.—These depend on the *amount* of toxins or ptomains absorbed *and the facilities for drainage.* While the large majority of cases recover under prompt treatment, occasionally the amount of absorption is so great as to overcome the patient's resisting power even though drainage has been instituted.

Treatment.—All recesses and pockets should be carefully opened and drained so as to prevent any further absorption, and followed by thorough irrigations. Murphy's proctoclysis is the remedy to dilute the toxins and stimulate the function of the kidneys to the maximum. Purgatives of calomel are indicated. Alcoholic stimulants are administered. Highly nutritious liquid diet is given every three hours. Fever is reduced by tepid baths

and ice caps applied to the head and over the region of the heart. Hypodermatic medication of strychnin, digitalis, or camphorated oil is in order.

Septicemia.—*This is a general infection caused by the absorption of pyogenic bacteria and their toxins, in contradistinction to septic intoxication, in which disease bacteria are not absorbed.* Septic intoxication as I have already told you depends on the size of the dose of toxins absorbed, while in septicemia the primary dose of bacteria and their toxins may possibly be small, but the incessant multiplication of the absorbed bacteria increases the amount of toxins proportionately, so that the dose is becoming greater and greater. Again one of the essentials of septic intoxication is a large absorbing surface; while in septicemia a most insignificant wound, abrasion, or scratch may be the point of entrance of the bacteria. In septic intoxication after the cavity or pocket which contained the putrefactive material has been drained, absorption of the toxins or ptomains is immediately stopped and the economy has only to deal with the primary dose, but in septicemia, although the wound or abrasion through which the bacteria entered has been thoroughly sterilized the limit of our efforts is reached, because the microörganisms have already invaded the general blood-current and the dose of infection is constantly getting greater, unless the resisting powers of the body can overcome it. Therefore, in septic intoxication it is possible to mechanically stop absorption, in septicemia it is impossible.

Symptoms.—The early signs are the same as in septic intoxication, only more aggravated. If a patient has undergone an operation or has been delivered of a child and there is not that return of well being which is desired; if there is prostration, headache, digestive disturbances such as a coated tongue, loss of appetite, and constipation, it is suggestive of an impending infection. If the patient has received some wound or abrasion, the same may be painful, with the local signs of an acute inflammation; red streaks may be observed coursing along the skin-surface, which are indicative of an inflammatory action in the lymphatic vessels (lymphangitis); in addition the constitutional symptoms spoken of develop. After four or five days the patient suffers a severe chill, or possibly rigors, followed by an increase in temperature which may reach 104°F. from the first, with a proportionate increase in pulse. The temperature having a tendency to rise in the evening and recede the following morning, so that the clinical chart shows an "up and down" curve of a degree or two. Occasionally the temperature may fall practically to the normal for a day, only to rise again to an alarming point, with a corresponding increase of pulse. Profuse sweats are common. If the resisting powers of the economy are sufficiently great to overcome the infection, a gradual restoration to the normal occurs. If on the other hand there is a continual multiplication of bacteria and their

toxins, the patient drifts into a state of exhaustion and the so-called "typhoid" symptoms appear. The tongue becomes dry, cracked, and bleeding; sordes collect on the lips and teeth; the breath is foul; the patient develops a low-muttering delirium, and picks at the bedclothing; involuntary diarrhea ensues; the urine becomes less in amount and highly concentrated. Marked disintegrative changes occur in the blood. Inflammatory changes occur in the heart, lungs, liver, and kidneys.

Treatment.—After the primary point of infection has been thoroughly cleansed and treated *antiseptically* the treatment will be the same as in septic intoxication; in addition vaccines may be employed.

Nurse's Duties.—Same as in "Erysipelas." (q. v.)

Pyemia.—*This is an acute general infection, having as its characteristics the formation of abscesses in portions of the body remote from the primary point of infection, and accompanied with irregular chills, fever of an intermittent type, and sweats.*

Causes.—When speaking on the subject of thrombosis I explained that when the thrombus was of the infectious variety and suppuration occurred in the clot the fragments became detached, floated in the blood-current, and were known as septic emboli. These infectious particles laden with bacteria and their toxins lodge in remote organs, and form the starting points for abscesses. Again, when speaking of the principles of infection, you were taught that bacteria could enter the circulation either through the medium of the lymphatics or by direct invasion of the capillaries. In either case after these microörganisms have gained entrance into the circulation, they are disseminated to various organs and become the starting points of abscess formation. Thus you can easily understand that during the course of septicemia (in which bacteria are propagated within the blood-current), a pyemia can easily develop; because the microörganisms lodge in various tissues and organs and become the factors in the production of abscesses; in fact septicemia is the most common cause for the development of pyemia.

Symptoms.—The train of symptoms is not as rapid, nor do they appear as soon, as those of septicemia. The patient possibly has suffered for some time with thrombophlebitis, or some suppurative process, when suddenly a severe chill occurs, followed by a temperature which may rise to 104° or 105°F., with a corresponding pulse. These symptoms are succeeded by profuse sweats. The temperature recedes two or three degrees, and the patient feels somewhat improved. Suddenly another chill occurs, followed by a higher degree of fever and debilitating sweats. If the process of infection continues, the chill which occurred every day or two may appear daily or two or three times a day, each time succeeded by a rise in temperature,

sweats, and finally a drop in temperature, so that there is a wide range in the excursions of the mercury. The chills are irregular, because there is no regularity in the formation of the different abscesses, nor in the elimination of the toxins. You can easily understand the profound impression which is being made on the economy. The amount of toxic material poured out through the kidneys is causing inflammatory changes to take place in these organs and impairing their function of elimination. Thus the toxic elements are retained within the body, and only serve to break down the natural resisting powers. The appetite fails, making it necessary to force the patient to take nourishment. Diarrhea is present, and in protracted cases becomes involuntary. The various organs of the body undergo inflammatory changes—especially is this true of the heart and its coverings. The effect on the brain and nervous system is manifested by muscular twitchings, picking at the bedclothes, and low-muttering delirium. Very few cases of true pyemia recover.

Treatment.—All accessible abscesses are immediately opened and drained. Alcoholic stimulation and a highly nutritious liquid diet are administered. Murphy's proctoclysis, as in other general infections, becomes a sheet anchor. Heat is applied during the period of chills, tepid sponging when the temperature is excessive. Alcoholic baths are indicated to keep the mouths of the sweat glands free and assist the kidneys in their elimination. Vaccines are becoming more popular in the treatment of this disease.

I have had several cases which undoubtedly owe their recovery to the administration of autogenous vaccines. (See lecture on "Surgery, Surgical Nursing, Infection," etc., section "Vaccines.")

Nurse's Duties.—Same as in "Erysipelas." (q. v.)

Pneumonia.—This complication may occur *immediately* after an operation, or develop some days *later*. In the former case it is generally produced by an excessive amount of anesthetic; the use of dirty masks and inhalers; undue exposure of the patient on the operating-table, especially when surrounded by wet clothing the result of the improper method of preparing the field of operation after the patient is on the operating-table. A pneumonia appearing some days after an operation, as a rule, develops from a septic process occurring elsewhere in the economy. Frequently the pulmonary complication is not recognized, and the aggravation of symptoms is attributed to the septic process from which the pneumonia developed.

Treatment.—This is the same as for pneumonia occurring at other times, viz., the employment of the cotton jacket, plenty of fresh air, the minimum amount of anodynes to relieve local pain and control the cough, and the use

of stimulants; especially are stimulants indicated in a pneumonia developing from some septic condition.

Acute Obstruction of the Bowel.—I desire to consider only such obstructions as occur immediately after abdominal operations.

Causes.—During the necessary manipulations within the abdomen which occur during a celiotomy the bowel may become twisted on its mesentery, or adhesions form between the intestines and some other organ, or between one portion of the intestine and another caused by the denudation of the peritoneum. These adhesions cut off the peristaltic action of the intestine to the extent of obliterating the fecal current. A similar accident occurs when the muscular coat of the intestine has been damaged. Strangulation of the gut may occur, or at least peristalsis abolished by the intestine insinuating itself in a rent or tear of the omentum which was produced during operative procedures. To be concise, any acute mechanical cause which interferes with the fecal current will produce the symptoms of an obstruction.

Symptoms.—The symptoms of an acute obstruction are very similar to those of acute peritonitis, in fact at times it is very difficult to diagnosticate between the two conditions. Severe colicky pains are usually the first manifestations, subsiding at times only to recur. Tympanites makes its appearance as an early symptom. The character of this sign will depend upon the site of the obstruction. As a rule the surface of the abdomen has not the perfect contour seen in peritonitis. One portion of the abdomen will be more distended than another so that an uneven appearance is observed. Vomiting soon develops; at first the fluids of the stomach, later bile, and finally the bowel contents (stercoraceous vomiting). This symptom is incessant, and with the paroxysmal pains, soon exhausts the patient. Thirst is insatiable. The loss of animal fluids due to the vomiting produces a dry and parched tongue, and a diminution in the quantity of the urine excreted. If the obstruction is complete there will be no escape of gas by the rectum; a small amount of fecal matter may occur after the use of enemata, which simply indicates the mechanical ejection of whatever residue there is in the lower bowel. The temperature and pulse at first are elevated; the latter becomes more rapid, and the temperature drops below par in proportion to the exhaustion of the patient. The Hippocratic expression soon develops. Palpation at times reveals a mass corresponding to the site of obstruction, but frequently the excessive tympanites and the severe pain which the patient suffers preclude a thorough examination by this means.

Treatment.—The obstruction being mechanical can only be relieved by mechanical means,—surgical interference is indicated. Nourishment and

fluids by the mouth should be withheld, as these only serve to increase the vomiting and exhaust the patient. Cathartics are absolutely contraindicated.

Nurse's Duties.—Before operative interference her duties will be similar to those given under "Tympanites" and "Peritonitis." After an operation has been decided on her duties will be the same as in any other abdominal operation, excepting that no preparatory treatment is given. If the first dressings have not been removed, the only cleansing necessary will be the use of tincture of iodin or Harrington's solution around the abdominal incision.

External Fecal Fistula Following Celiotomies.—*An external fecal fistula is the pathway by which the contents of the bowel escape through an artificial opening. The feces appear on some portion of the abdominal surface.*

Causes.—Mechanical injury to the intestine during an operation, as in separating adhesions, pressure from drainage tubes, abdominal and pelvic abscesses, defective intestinal suturing.

Symptoms.—The first symptoms will be noticed about the second or third day after the operation; occasionally a longer period will elapse before the first manifestations are noticed. Pain is complained of in the abdominal incision, and there is an increase of temperature and pulse rate. On inspection the wound appears inflamed and exudes a thin, purulent, odoriferous discharge. If the coaptating stitches are removed, which of course should be done immediately, the escape of fecal matter may occur; or, which is more frequently the case, a day or two later. Such a complication occurring in a newly made wound produces suppuration. The irritating discharges from the fistula cause a dermatitis of the surrounding skin. The odor becomes unbearable and necessitates frequent change of dressings.

Treatment.—The large majority of fecal fistulae heal without surgical interference if kept cleansed with mild antiseptic solutions. The sinus itself should not be irrigated before the end of the first week through fear of disturbing the protective adhesions which have been thrown out; and *even then the irrigating solution must be allowed to flow very gently.* A liquid diet is maintained so as to leave as little residue in the bowel as possible. If these means fail to accomplish a cure a surgical operation is necessary. The skin around the fistula should be protected with zinc ointment to prevent an eczema developing from the irritating fecal discharges.

Erysipelas.—*This is an acute infectious disease characterized by inflammation of the skin and mucous membrane; the result of the presence of the streptococcus.* In the pre-antiseptic age this was one of the most common

surgical complications. Modern ideas of isolation and present methods of wound treatment have made it one of the rarest sequelae encountered.

Causes.—There are two causative factors in the production of erysipelas, viz., (1) a breach of surface continuity, and (2) the entrance therein and the multiplication of the streptococcus.

It is not the province of this lecture to enter into a discussion whether there is a specific variety of the streptococcus which produces erysipelas; some authorities claim there is, others assert it is the ordinary pyogenic streptococcus found in other inflammatory conditions. The question has not yet been definitely settled. In the vast majority of cases the erysipelatous inflammation is confined to the skin, but in the more severe types the deeper tissues are involved.

Symptoms.—As a rule there are no premonitory constitutional symptoms. From one to three days after an accident has been received a chill makes its appearance; followed by a rise in temperature and a proportionate pulse rate. A reddish blush appears from one of the edges of the wound or abrasion, extending forward in the natural skin; its margins clean cut and indicating the path taken by the infection. This redness continues to extend, and at times involves a large surface. In other instances red streaks "jut out" from the main area, indicating the course of the superficial lymphatics The patient complains of a burning pain and itching at the site of inflammation. Palpation of the inflamed part reveals a tension over this blush when compared with the soft elastic feeling of normal tissue. If pressure is made by the examining finger on the erysipelatous area, the red color disappears momentarily and gives place to a yellowish tint; immediately however the redness reappears. In the severer froms the infected surface is slightly raised; vesicles or blebs form, from which a thin serous exudation escapes. If the erysipelatous infection is situated in loose tissue, as in the face for instance, great swelling ensues; the eyelids become edematous, and the expression greatly distorted. The tendency of the disease is to spread by continuity of tissue. Constitutional symptoms occasionally develop *before* the local signs I have described, *but this is not the rule.* The temperature which succeeds the initial chill does not recede as in septicemia and pyemia, but remains the same or possibly higher. This peculiarity is considered diagnostic. Occasionally the fever is intermittent or remittent. After the development of the infection such general symptoms as headache, pain in the limbs and joints, and digestive disturbances make their appearance. *If the local infection becomes general the constitutional symptoms are proportionately severe;* the coated tongue becomes dry and bleeds easily, sordes accumulate on the teeth and lips, muscular twitchings and low-muttering

delirium develop as the result of the toxemia. The usual complications found in the deeper organs are not as frequent as in other infections.

Treatment.—The erysipelatous patient should be isolated, in spite of the fact that some surgical authorities claim that it is unnecessary.

Local.—Drugs applied locally have very little influence on the course of the disease. Moist dressings of carbolic acid 1 per cent., or corrosive sublimate 1:2000, or a 25-per cent. mixture of ichthyol and ethereal collodion are used. Bier's hyperemic treatment has given me the best results. (See lecture on "Surgery, Surgical Nursing, Infection," etc., section "Bier's Hyperemic Treatment.")

Constitutional.—Some surgeons advocate injections of the antistreptococcic serum. The internal administration of drugs has not given satisfactory results. A nutritious liquid dietary, laxatives, and tepid bathing to reduce the temperature, is the indicated treatment in the majority of cases. In the more severe types alcoholic stimulation and the use of rectal infusions are in order.

Nurse's Duties.—Septicemia, pyemia, and erysipelas are exceedingly infectious diseases which are capable of being communicated to other surgical patients through the careless work of a nurse and improper technic. The greatest care therefore should be exercised to prevent the carrying of infection from the affected patient to others. *In fact it is highly proper for a special nurse to have exclusive care of patients suffering from these diseases, and not be allowed to mingle with the other nurses or assist in the dressings of other surgical cases.* Moreover the eating and drinking utensils of such patients should be kept exclusively for their use and not indiscriminately placed around to be used by others. The face towels, nightgowns, bedclothing, and nurse's outfit should be boiled previous to being sent to the general laundry. The basins, douchecans, and rubber gloves employed in the case should not be laid aside with a promise of future sterilization, but should *immediately* go through such process. The dressings which are changed from day to day should at once be cremated. The same careful technic in the personal toilet of the nurse, especially in the use of gloves and gowns, is compulsory. The preparation of the solutions, basins, and douches as have been previously described should be carried out to prevent any secondary infection. Simply because a patient is suffering from an infectious disease is no reason why the same care should not be exercised as though no infection were present. In fact it is your duty to be all the more careful in your manipulations. The room occupied by the patient should be thoroughly fumigated before being used again by another.

Tetanus—Lockjaw.—*This is an infectious disease characterized by spasms of the voluntary muscles, due to the effects of a toxin on the spinal cord and medulla. The toxin is derived from the tetanus bacillus.*

Acute tetanus or lockjaw is an exceedingly uncommon postoperative complication and is only mentioned in this connection because of certain peculiarities connected with the disease, which if understood, assist the nurse to a great extent in caring for the patient.

The *mode of entrance into the economy* in the large majority of cases *is through the medium of a wound. The tetanus bacillus can only develop in a location where atmospheric air is excluded;* that is to say, *it is anaerobic* (developing without oxygen), hence its effects are only manifested in the economy *either after a wound has healed, or when an injury is of such a character as to prevent air from coming in contact with the bacillus*—such as gunshot, stab, or punctured wounds. The natural habitat or home of the tetanus bacillus is in *dust, dirt, and manure.* The popular notion of the dangers of a wound produced by a rusty nail has some philosophy in fact. This means of injury does not produce lockjaw because of its being *rusty,* but from the fact that it is liable to be covered *with dust infected with the tetanus bacillus,* and *produces a wound conducive to the exclusion of oxygen.* On the other hand the nail or means by which a wound is produced may not be contaminated with the tetanus bacillus, *but the part wounded may be the resting place of such microörganism* and entrance is gained into the economy either at the time of injury or subsequently.

The impression that the *cartridges of toy pistols are the source of infection* of the numerous cases of lockjaw which occur after the Fourth of July is *erroneous. The dust and dirt on the hands of the victim is the medium* through which the bacillus gains entrance after an injury has been received, *whether it be from a toy pistol or other means of celebration*

It is possible that the tetanus bacillus may gain entrance into the economy through the *respiratory, genital, or digestive systems, but these avenues are exceedingly rare.*

After entrance into the tissues has been gained and atmospheric air excluded, other peculiarities of this microörganism are noted. No inflammatory action is observed around the point of invasion unless a mixed infection is present. The effects on the economy are not due to the propagation of the bacillus in the blood, nor to the development of pus, but to the elimination of toxins. *The wound may have healed entirely, or present a most harmless appearance, when the first signs of tetanus manifest themselves.*

To Meyer and Ranson, as quoted by Dr. Charles H. Frazier of Philadelphia, the profession is indebted for the most important additions to our

knowledge of the manner of development of the disease. The following deductions have been made from the very excellent article of Dr. Frazier:

The toxin of tetanus is carried to the spinal cord and medulla by way of the motor nerves; never through the sensory portion of the nervous system. After the toxins are eliminated *locally* the motor-nerve endings around the site of injury become the *media* by which a portion of the toxic material is transmitted to the cord. Other portions of the toxins in the wounded area are absorbed by the lymphatics and eventually emptied into the blood-current. (See lecture on "Surgery, Surgical Nursing, Infection," etc., section "Lymphatic System.") The capillaries while performing their normal function of disseminating the nutritive principles of the blood to the various tissues also eliminate these toxins, which are absorbed by other motor-nerve endings and a similar process of transmission of this poisonous material to the cord occurs; so that this toxic principle is reaching the motor tracts in the cord not only from the motor nerves at the original site of injury; *but from motor-nerve terminals situated all over the economy.* Having entered the cord the toxin spreads upwards until the medulla is reached. The action on the cord is simply one of *excessive excitability on the motor tracts.* The sensory portion of the cord is affected by reflex action.

Symptoms.—The symptoms manifest themselves between seven and ten days from the time of the wound, during which period several conditions are developing—

(1) The exclusion of atmospheric air around the tetanus bacilli to permit their development.

(2) The elimination of toxins.

(3) The absorption and conduction of these toxins to the cord by the motor nerves.

The disease therefore is practically developed before its true signs are manifested. As a rule the first symptom is a stiffness of the neck, which is shortly followd by a rigidity of the muscles of the jaw (trismus), so that the patient is unable to turn the head from side to side or open the mouth. Spasms of the muscles of the face develop, producing that peculiar expression known as "risus sardonicus." The muscles of deglutition become rigid, as well as those of the abdomen and extremities. Contraction of the muscles of the back develops to the extent that the patient is arched like a bow and lies on his heels and occiput (opisthotonos), or assumes other contorted positions. The picture thus far is one of *tonic spasm;* that is to say, a condition of *continuous rigidity* and *contraction of the muscles.* Through some peripheral irritation such as a sudden noise, jarring of the bed, drafts of air, hypodermatic medication, the condition is changed to one of *clonic convulsions,* by which is understood *alternating contraction* and *relaxation*

of the muscular system. These convulsive seizures vary in frequency and duration and are accompanied by pain of a very agonizing character.

On account of the rigidity of the muscles of deglutition and mastication only liquid nourishment can be given, and even this is swallowed with great difficulty. Difficult breathing (dyspnea), as would be expected, is present because of the rigidity of the muscles of respiration and the spasms of the diaphragm and glottis. Profuse sweats bathe the patient. Constipation and retention of urine are common. Throughout the continual tonic and clonic spasms the patient's mind remains clear with a perfect realization of his true condition, and with the added misfortune of being unable to articulate. The temperature at first is slightly elevated, but rises generally before death.

Chronic Tetanus.—Formerly by this term was understood a prolonged period of incubation, while the modern acceptation implies the *duration of the disease,* which is certainly the more correct interpretation. The symptoms of this form are the same as those seen in acute tetanus, only not as pronounced and with longer intervals between the convulsive seizures, affording the patient an opportunity for recuperation and obtaining nourishment. Relapses are occasionally seen.

Prognosis.—This is unfavorable in acute tetanus, but with the present knowledge of the manner in which the toxin is disseminated and the proper technic in the administration of the antitoxin, the profession is in a better position to appreciate the avenues by which the toxic material should be attacked. For this reason I think the mortality in the future will be reduced. The longer the duration of the disease the more favorable is the outlook.

Treatment—Local.—Prophylaxis should play an important part. When any wound has been received of such a character as to prevent a thorough ablution of its cavity, it should be immediately laid open so that all recesses can be cleansed, damaged tissue removed, and a free exit afforded for discharges. *This is especially indicated when the environment and condition of the patient at the time of the injury are of a nature to suggest the possibility of such an infection occurring as the one under consideration.* In addition immunization of the patient by injections of antitoxin at the site of injury and intravenously should be made; the frequency of repetition depending on the views of the surgeon.

Unfortunately in all cases which have come under my observation, and I suspect the same is true in the experience of other surgeons, the injury has been of such minor importance that the patient paid no attention to it until the constitutional signs of tetanus developed. *At this stage local treatment is compulsory even though the wound has healed.* A careful dissection of the part should be made in an endeavor to remove the base of supply from

which the toxins are eliminated, followed by thorough irrigations of the wound with a 2-per cent. carbolic-acid or tincture-of-iodin solution. Iodoform gauze is used as a dressing as in other infected wounds. *Caustics are positively contraindicated,* inasmuch as these coagulate an albuminous deposit, forming a shelter for the bacilli by excluding air, and favoring their development.

Constitutional Treatment.—I shall not attempt to describe the various methods which have been advocated, but confine my remarks to the treatment with antitoxin, as I am firmly convinced this will be the means adopted in the future. *As far as is known the tetanus antitoxin is not absorbed at all by the nerves.* It is therefore necessary to introduce the *antitoxin directly into the nerve to block the course of the toxin.*

The summary of our knowledge therefore is as follows:

(1) The *motor nerves* are the paths of transmission by which the toxin reaches the cord.

(2) The toxin comes in contact *primarily* with the motor-nerve endings at the site of injury.

(3) The toxin reaches other motor-nerve terminals *secondarily* by way of the circulation.

(4) The antitoxin is not absorbed by the nerves; hence it is necessary to introduce it mechanically.

With this knowledge, the philosophy of the plan of injections as utilized by Rogers can be appreciated—

(1) The subcutaneous injections at the site of injury to render inert the toxins present.

(2) Intravenous injections to neutralize the toxins in the blood-current.

(3) The direct injections of the antitoxin into the nerve supplying the member which received the primary injury to block the course of the toxin.

(4) The direct injections of the antitoxin into the cord at a suitable level to protect the vital centers in the medulla from further invasion by the toxin.

The injections of the antitoxin should be made daily, or even twice a day, because its elimination from the body is very rapid and only a small amount is absorbed. The dose is *ad libitum, as the serum is perfectly harmless.* These are matters which concern the surgeon exclusively. *Intravenous injections* of normal salt solution are utilized to favor the elimination of the toxins.

Drugs.—Of all the numerous drugs which have been recommended chloral hydrate and morphin are possibly the best. These are administered

in an endeavor to prevent the paroxysmal seizures; the former is frequently given per rectum in solution, while the latter is administered hypodermatically. If these medicinal agents are ineffectual chloroform anesthesia is employed with the same end in view,—to afford the patient rest.

Diet.—A liquid and highly nutritious diet is indicated. If the muscles of deglutition permit of swallowing, food is administered by the mouth, otherwise nutrient enemata are resorted to.

General Measures.—The patient should be placed in a dark room, remote from noise and other irritations which are known to influence the convulsive seizures. Friends and relatives should be excluded. Catheterization is frequently necessary because of the rigidity of the sphincter of the bladder. Attention must be paid to the evacuation of the bowel.

Nurse's Duties.—These are self-evident.

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LECTURE XXIV

MAJOR SURGERY IN PRIVATE PRACTICE

It frequently becomes necessary for the surgeon to forego the many conveniences afforded by a hospital for operating and to improvise an operating-room at the home of the patient, in many cases miles remote from his base of supplies, and often far distant even from the country drug store. Unless the case be one whose physical condition prohibits transportation, the patient should always be brought to the hospital where the surgeon is accustomed to operate. The reasons for this should be self-evident, because whatever care is exercised in carrying out the many details necessary for the preparation of an operation at the home of the patient, danger of breaking the "chain of asepsis" is constantly present; the various makeshifts that are utilized curtail to a great extent the surgeon's freedom; the after-treatment is not under the supervision of the attending surgeon,—a point of infinite importance in the final results.

This is the occasion of all occasions when the surgeon should surround himself with such assistants and nurses as are familiar with his technic, and on whom he can rely implicitly to carry out the multitudinous details which will arise. His usual hospital assistants accompany him on the day of operation; the nurse is selected and dispatched to the home of the patient the *day previous,* if the exigencies of the case permit.

Nurse's Immediate Duties.—(1) Ascertain the full name and address of the patient, the facilities for transportation, whether provisions have been made for your reception at the depot, and if not, get directions for reaching your destination. This may seem superfluous, but it is not.

(2) Unless thoroughly acquainted with the surgeon's technic, ascertain the following facts:

(a) His method of preparing the field of operation.

(b) His views of hand sterilization.

(c) The character of the diet to be given the patient the day previous to operation.

(d) The kind of cathartic desired administered to the patient.

(e) The hour scheduled for the operation.

(f) Whether morhpin gr. 1/4, atropin gr. 1/150 (or hyoscin gr. 1/200) is to be administered before time set for operation.

(g) Ascertain the position in bed the surgeon desires the patient to assume immediately after the operation.

(3) Have a thorough understanding with the surgeon as to what articles *you will be expected to take,* and *those he will be responsible for.* As a rule the surgeon is connected with some hospital where he is in position to obtain the necessary dressings, sponges, towels, gowns, caps, etc., already sterilized in properly protected packages. It will be more convenient therefore for him to assume the responsibility for these articles, but such necessities as sheets and blankets the nurse should procure from the patient's home, while the towels are especially included in the hospital packages the surgeon will bring because they will be more thoroughly sterilized.

(4) Purchase the following supplies:

(a) 100 mercuric tablets.

(b) 100 normal saline tablets.

(c) 8 ℥ carbolic acid.

(d) 4 ℥ tincture iodin.

(e) 4 ʒ solution adrenalin.

(f) 2 pints alcohol.

(g) 1 pint brandy or whiskey.

(h) 1 paper safety pins.

(i) 4 ordinary wooden hand brushes.

(j) 5 yards of plain sterile gauze which will be needed before the surgeon arrives with the hospital supplies.

(k) 1 yard rubber sheeting.

(l) Such other articles as are necessary for the sterilization of hands and field of operation according to the views of the surgeon, which you have already learned.

I have purposely omitted green soap or tincture of green soap because the ordinary laundry soap answers all purposes admirably. Such a list as has been suggested should be neatly typewritten and pasted inside the nurse's grip, satchel, or suit case as a check that nothing has been omitted.

Obtain a receipted bill for the above articles and present it to the head of the family at an appropriate time; this will in no way disparage you, but only demonstrate your businesslike methods.

(5) Prepare your professional equipment by including the following articles:

(a) 2 pairs rubber gloves.

(b) 2 operating-gowns and 1 operating-cap previously sterilized.

(c) 1 porcelain douchecan equipped with rubber tubing, appropriate nozzles for rectal enemata, proctoclysis, and vaginal douches, and which will serve the purpose for an infusion reservoir if needed.

(d) 1 infusion needle.

(e) 1 soft rubber catheter (about 17 French), 1 glass female catheter, 1 rectal or colon tube.

(f) 1 collapsible tube of sterilized vaselin.

(g) 1 safety razor, or a depilatory powder according to the formula given in the lecture on "Preparation of Patient for Operation."

(h) 1 clinical thermometer.

(i) 1 pair of bandage scissors, 1 pair of sharp-pointed scissors, 1 pair of dissecting forceps.

(j) 1 hypodermic syringe, fully equipped with the following tablets:
Strychnin sulphate gr. 1/30.
Morphin (plain) gr. 1/4.
Morphin gr. 1/4-atropin gr. 1/150; or morphin gr. 1/4-hyoscin 1/200.
Digitalin gr. 1/60.

(k) Hot-water bottles may be included, but the common beer bottle with self-retaining stopper, or the ordinary mason jar as found in every household, answers admirably as a substitute.

Surgeon's Outfit.—In order that there shall be no misunderstanding this will include:

(a) Operating instruments and needles, besides various kinds and sizes of suture and ligature material.

(b) Sterilized suits, gowns, caps, and gloves for himself and assistants.

(c) Sterilized dressings, sponges, towels, bandages, or abdominal binder in original protective packages. Possibly a jar of iodoform gauze.

(d) Adhesive plaster and drainage tubes.

(e) Kelly pad (optional).

(f) Anesthetic, inhalers and cones.

Some surgeons add a *skeleton table,* or a *Trendelenberg frame* (which latter can be adjusted to an ordinary kitchen table) to this list of supplies.

It should be previously understood if these will be brought by the surgeon or substitutes provided in a way to be described later.

Duties of the Nurse on Arrival at the Home of the Patient.—At once endeavor to gain the confidence of your patient and demonstrate to the family that instead of being a useless appendage, your presence is a necessity. Remember in all the details that are carried out to perfect a "chain of asepsis" you will constantly be in contact with persons, who, while willing to assist, are utterly ignorant of the first principles of true asepsis. Be kind and considerate, yet firm in your views, and ever watchful that the labor expended in sterilizing necessary articles, cleansing furniture, etc., does not go for naught by the thoughtless interference of some one: in short, be the executive in the absence of the surgeon.

Extemporized Operating-room.—Frequently the surgeon makes the selection of the temporary operating-room at his first visit, but occasionally it becomes the duty of the nurse. In selecting such an apartment there are several factors to be taken into consideration, such as the location, size, and facilities for light. Therefore choose—

(1) A large and commodious apartment.

(2) Remote from the noise of the general living-room and where morbidly curious visitors can be shut out.

(3) With a northern exposure if possible; if this cannot be obtained, an eastern exposure for morning, and a western for afternoon operations.

(4) A room that has not been lately occupied by a patient with some acute infectious disease. (See double-page illustration LV.)

Preparation of the Room (when time will permit).—

(1) Remove all furniture, carpets, curtains, window shades, and pictures.

(2) If the operation occurs during cold weather and the room is heated by an open fire, substitute a closed stove if possible, if chloroform is to be the anesthetic employed which occasionally is the case, as the fumes from this drug mixing with the open fire produce a gas which is exceedingly irritating; in fact I have witnessed a partial asphyxiation from this source. Cloths moistened in ammonia water and hung around the room will neutralize the effects of these irritating fumes.

(3) With an ordinary straw broom covered with a clean cloth, frequently changed, sweep the ceiling and walls of the apartment thoroughly and systematically.

(4) With soap and water wash the woodwork and windows, paying strict attention to such portions as favor the accumulation of dust, such as the

caps of doors, windows, and mantel. Chemical antiseptics must not be used, as these spoil the finish of the wood and subject the nurse to criticism.

(5) Have the floor thoroughly scrubbed with soap and water, and finally mop it with a solution of mercury 1:1000, or carbolic acid 1:20. If the floor is of the modern hard-wood type omit the antiseptics.

(6) In order to obstruct the view of outsiders and not interfere with the entrance of light, frost the lower half of the windows with a paste made of pipe clay or soap, or sash curtains of thin material may be adjusted.

(7) Open the windows to allow the room to thoroughly air for two or three hours.

(8) Close and lock the door of the apartment.

A List of Necessary Articles.—

(a) 1 ordinary kitchen-table to be used for an operating-table. If the Trendelenberg position is to be utilized reinforce the legs by nailing cleats from one to the other. In addition have made a substantial box, 10 inches high, 10 inches wide, and a little longer than the width of the table to serve as an elevator for one end of the table to produce the desired position. If the table is not long enough any ordinary carpenter can easily make an extension. A dining-room table is unfit for surgical operations because of its extreme width.

(b) 1 large table for sponges and ligatures.

(c) 1 small stand (marble top preferred) for instruments.

(d) 1 bench for the basins in which the surgeon and assistants make their primary toilet.

(e) 2 small chairs, one for the anesthetist and the other for the surgeon if the operation be on the vagina, rectum, etc.

(f) 6 basins {
2 for surgeon's hands when making his toilet.
2 for surgeon's hands during the operation.
2 for sponges.

(g) 4 pitchers {
2 to contain saline solutions for sponges.
1 to contain sterile water.
1 to contain mercuric solution 1:2000, for the preparation of the surgeon's and assistant's hands.

(h) 1 porcelain douchecan.

(i) 1 laundry tub as a waste receptacle.

(j) 1 slopjar to receive the drainage from the Kelly pad if one is used.

(k) 2 wash boilers for hot and cold sterile water.

(l) 1 long-handled dipper to be used with the sterile water in the boilers.

(m) 3 blankets { 1 large, with which to pad the operating-table.
2 small, to protect the patient during the operation.

(n) 3 sheets {
1 to be used as a cover for the operating-table.
1 to be utilized in a similar manner for the sponge- and ligature-table.
1 as an operating sheet. If the case is a celiotomy an oblong aperture is cut in the center to correspond with the site of the operation (so-called celiotomy sheet).

(o) 1 small pillow and corresponding muslin slip.

(p) 1 yard rubber sheeting (purchased by the nurse).

(q) 4 wooden hand brushes (purchased by the nurse).

Up to this point the temporary operating-room has been prepared and such articles selected as will be necessary to furnish it.

Sterilization.—

(1) The tables and chairs are thoroughly scrubbed with soap, water, and brush, then rinsed with a solution of bichlorid of mercury 1:1000, or carbolic acid 1:20, the latter being preferable as less liable to damage the finish of the furniture.

(2) Remove to the operating-room immediately.

(3) The basins, pitchers, and douchecan are washed thoroughly in soap and water, rinsed in boiling water, placed in the operating-room and filled with mercuric solution 1:2000 or carbolic acid 1:20, where they remain until the next morning. This is the best means of sterilizing these articles as the ordinary household does not have a receptacle large enough to boil them in, and the usual recommendation to submerge them in the bathtub is frequently not practical.

(4) The laundry tub and slopjar which are to serve as waste receptacles are simply scrubbed with soap and water and immediately placed in the operating-room.

(5) The wash boilers go through a very careful scrubbing, are then rinsed and scalded, filled with hard water (not the dirty cistern water so commonly used), and placed on the stove to boil for twenty minutes. The dipper is sterilized by being suspended in one of the boilers. They are then removed to the operating-room.

(6) The sheets, blankets, and pillow-case are wrapped in separate covers, placed in the ordinary oven, the door of which is left slightly ajar, and

sterilized by the "fractional method," which has already been described in the lecture on "Antiseptics, Disinfectants, Germicides," etc., section "Sterilization by Heat." After being sterilized remove these articles to the operating-room.

If the surgeon decides not to bring towels, then the same must be secured at the home of the patient and sterilized in the same manner as the sheets, blankets, etc. There should be at least 12 or 15 of these articles.

(7) The rubber sheeting is washed with soap and water, then sponged thoroughly with mercuric or carbolic solution.

(8) The hand brushes after being enclosed in a wrapper are boiled.

Preparation of the Patient.—This has been given in detail in the lecture devoted to this subject. Some slight modifications may be required by the attending surgeon, but the basic principles involved will be the same. The necessary equipment such as soap, brush, antiseptics, alcohol, etc., are at hand. After the field of operation has been prepared, protect the same with several layers of the plain sterile gauze which was purchased with the supplies, and hold in place with an improvised abdominal binder (roller towel).

Preparation of the Patient's Bed.—If the operating-room is large and commodious it is frequently used as the future bedroom of the patient; under such circumstances, after the bed is prepared it is placed in one corner of the room. If the room is small it is better to have a separate apartment.

(1) Select a single iron bedstead if possible, with a good mattress.

(2) Thoroughly wash the bedstead with soap and water.

(3) Air the mattress and pillows.

(4) Assemble the bedstead.

(5) Prepare the bed according to hospital custom, details of which have been given you.

(6) If the Fowler position is to be used an extemporized back-rest must be provided, which is easily accomplished by utilizing a chair turned upside down and padded with pillows, or an elevator made similar to the pattern already described. (See lecture on "Principles and Practice of Postoperative Nursing," section "Preparation of the Fowler Position.")

Nurse's Duties the Day of the Operation.—If the various steps given you have been carefully carried out a couple of hours will be ample time to complete the final details, which will be as follows:

(1) Assume a clean gown and cap and thoroughly prepare your hands without gloves.

(2) Have one of the boilers of sterile water placed on the stove heated to the boiling point and then returned to the operating-room beside the boiler

ILLUSTR.

An Extemporized Operating-room.—Note the elevation of the operating-table by

N LV

ans of a box or block of wood in order to obtain the Trendelenberg posture

containing the cold sterile water,—thus the temperature of the different solutions can be regulated. Locate both convenient to the sponge-table.

(3) Place the operating-table in the most advantageous light.

(4) Arrange sponge-table and instrument-stand according to hospital custom, i. e., one on either side of the operating-table.

(5) Locate the basin bench in a remote part of the room.

(6) Locate the laundry tub in a convenient position to the sponge-table.

(7) Cover the sponge-table with one of the sterilized sheets.

(8) Empty the basins and pitchers filled the day previous with antiseptic solutions, and rinse them thoroughly in sterile water.

(9) Thoroughly cleanse the outside of the bottles containing the various antiseptics, etc. With clean hands tie a piece of sterile gauze around each container.

(10) Locate on the sponge-table the following:

(a) Bottles containing antiseptics, etc.

(b) 4 basins { 2 for sponges.
2 for surgeon's hands during operation.

(c) 2 pitchers for saline solutions to replenish sponge-basins.

(d) The dressings, sponges, etc., which the surgeon will provide.

(e) The small blankets and celiotomy sheet which cover the patient during the operation.

(11) The instrument-stand will be covered with sterile towels provided by the surgeon, previous to the instruments being placed thereon.

(12) On the basin bench are placed the following:

(a) 2 basins.

(b) 2 pitchers { 1 for sterile water.
1 for mercuric solution 1:2000.

(c) Muslin wrapper containing hand brushes.

(d) Soap.

(e) Such special antiseptics as the individual surgeon employs for hand sterilization.

(13) Prepare the operating-table as follows:

(a) Cushion the top with the large blanket folded to fit.

(b) Protect the blanket with rubber sheeting.

(c) Cover this latter with the sterile muslin sheet which should be tucked under the table and securely pinned.

(d) Inclose the small pillow in the sterile slip and place in position.

(e) Elevate the foot of the table with the box provided for that purpose, if the Trendelenberg position is to be used. This is especially necessary in obese patients.

(14) In these many steps which have been taken the nurse should have paid strict attention to her hands by frequent washing.

On the arrival of the surgeon several duties devolve on the nurse.

(1) The hospital supplies brought by the surgeon are located in their proper places.

(2) Cover top of instrument-stand with towels, on which the assistant will immediately arrange the instruments.

(3) Prepare solutions as follows (these have been left to the last so that they may be warm when needed):

- (a) 2 pitchers filled with normal saline solution to be used in the sponge basins.
- (b) 2 pitchers, one filled with mercuric solution and the other with plain sterile water for the sterilization of the surgeon's hands.
- (c) The solutions in the basins for the surgeon's use during the operation must be replenished frequently. Mercuric solution 1:2000 will be required in one and normal saline solution in the other.

After the surgeon's and assistants' toilets are completed and during the time the patient is being anesthetized, the nurse makes her own personal toilet as follows:

(1) Sterilize hands.

(2) Assume clean gown and two pairs of gloves.

Final Preparation of Field of Operation.—The patient being anesthetized and placed on the table the nurse carries out the following schedule:

(1) Surround the patient with the small blankets in such a manner as to leave the field of operation exposed.

(2) Cover blankets with sterile towels.

(3) Remove protective dressings.

(4) Cleanse the field of operation according to the surgeon's views.

(5) Cover the patient with the sterile muslin sheet; if the case be a celiotomy an aperture is made in the sheet corresponding with the field of operation.

(6) Remove outer pair of gloves and assume bib-apron.

Nurse's Duties During Operation.—

(1) Handle sponges and keep correct count of the same, if the case is a celiotomy.

(2) Replenish solutions when needed.

(3) Prepare ligatures and sutures if required to do so.

(4) Assist with the final dressings.

Preparation of the Temporary Operating-room when time is limited.—Occasionally, as in emergency cases, time will be so limited as to prevent a thorough preparation of the room. Under such circumstances carry out the following schedule:

(1) Remove only such furniture as necessary to afford free working space.

(2) Do not disturb the carpet, shades, curtains, or pictures, as in so doing the dust created will act as a medium for infection.

(3) Cover the carpet with moist sheets. Some surgeons require all furniture left in the room to be draped.

(4) If the operation occurs in the daytime, roll up the window shades and carefully drape back the curtains so as to permit as free light as possible; if at night, make provisions for artificial light.

Sterilization.—The cleansing of the extemporized operating-table and other stands which will be used, and the sterilization of the various articles which the household furnishes cannot be as thoroughly accomplished as when time is at our disposal, so that *antiseptics* play a greater part than on other occasions.

A simple way of sterilizing the basins and pitchers is the following:

(1) Scrub these articles thoroughly with soap and water.

(2) Rinse and dry thoroughly.

(3) Moisten the inner surface with alcohol and touch with a lighted match, care being taken to cause the flame to cover the inside of the vessel so that the heat will be equitably diffused, and thus prevent the utensil from breaking. However, use of the usual antiseptics for this purpose should be given the preference.

LECTURE XXV

GENERAL ANESTHESIA—ANESTHETICS

Introduction.—I have been undecided whether a series of lectures to nurses should include the subject of anesthesia. After consideration I have concluded to give what may be termed the stepping-stones, or first principles, of this important subject. I do not think for one moment that all of you will become anesthetists, and possibly no individual of this class may undertake to especially equip herself for this important duty, but any of you may be called upon to administer an anesthetic in an emergency. It is on account of such exigencies that may occur in your professional life that I invite your attention to this subject. At the present time a few of the best surgeons of the country are employing specially trained nurses as their anesthetists, because they realize that the large majority of physicians who undertake this special line of work sooner or later relinquish it for what appears to them a more remunerative field. I do not consider it appropriate to enter into a discussion as to the merits or demerits of the specially trained nurse-anesthetist. The few who have come under my observation have shown a dexterity in their work which, to say the least, has been very gratifying.

The principles on which the administration of anesthetics are based are founded on the knowledge of physiology, anatomy, and pathology, especially of the circulatory and respiratory systems. Moreover, the anesthetist should be thoroughly conversant not only with the physiologic action of the various drugs used to induce anesthesia, but the effects produced by such alkaloidal narcotics as are frequently employed in combination with general anesthetics. With such a foundation, the anesthetist is qualified to choose the proper anesthetic in a given case and proportionately to safeguard the patient. Dexterity in the administration of anesthetics must first be gained in the Kindergarten of Observation, supplemented by laboratory experiments on lower animals; then in the School of Administration under the supervision of a skilled teacher; and finally, the student may attempt their practical administration. Refinement, dexterity, and a keen appreciation of

the various stages through which the patient passes when under the influence of these drugs are gained only by large and extensive practical experience.

The time has passed, I hope, when the important duty of administering an anesthetic will be intrusted to the young and inexperienced college graduate, who as hospital intern hardly becomes efficient in the administration of these drugs before his term of service is ended, and his place filled by another inexperienced man who goes through the same experimental routine as his predecessor. In this way the lives of innocent and unsuspecting patients are jeopardized. Every hospital should afford an expert anesthetist who should receive a remuneration in proportion to the services rendered. This extra outlay of money need not add any expense to the institution. A patient who is willing to pay for an operation will be more than willing to pay a premium to one who can minimize the dangers of the anesthetic. Moreover the charity patient should be given an equal protection. If the surgeon is willing to give his services to the unfortunate poor, the anesthetist of the institution should be as philanthropic.

In connection with the trained versus the untrained anesthetist, Dr. E. H. Williams, San Francisco, Cal., in the St. Louis Medical Review (February, 1911) makes the following analysis of 2,400 cases of anesthesia;—half of this number was administered by *untrained interns,* the other half by a qualified anesthetist or by trained interns:

"(1) The untrained interns used over three times more ether. They averaged over three-fifths pound an hour as against less than one-fifth pound an hour used by the anesthetist.

"(2) They stimulated six times as many patients during operation, using twenty times the number of stimulants in all.

"(3) They had 41 per cent. more postoperative vomiting and this lasted much longer, often continuing for a number of days."

From my personal observation I am fully convinced that the above figures are in no way exaggerated, and they are cited simply to corroborate the statements already made that the administration of these drugs should be *restricted as far as possible to the specialist.*

In describing the administration of ether and chloroform I wish it to be understood that I have mentioned only the simplest methods. I have omitted the various forms of apparatus which have been designed for the administration of these drugs, some of which are entirely too elaborate for the student to comprehend; others are practical, but they are intended for the skilled anesthetist. Likewise, I have not mentioned the use of oxygen in connection with ether and chloroform,—a combination which I think deserves more consideration than has been accorded it. Nor have I touched on the subject of the administration of warm chloroform and ether instead

of utilizing these drugs at ordinary temperature. I am fully convinced the time is coming when the profession will appreciate the increased safety to the patient when the vapors of these drugs are employed warm.

Historical.—By the term anesthesia in surgery is understood the loss of sensibility of a *local part* (local anesthesia), or of *the entire body* (general anesthesia), produced by the physiologic effects of drugs. Drugs capable of producing this condition are called anesthetics.

To Dr. Oliver Wendell Holmes is due the honor of having suggested the terms anesthesia and anesthetic (1846).

From the earliest times of which we have any record the efforts of man have been directed toward the relief of pain incident to disease, injury, or surgical operations. Mention is made of such remedial measures in the writings of the ancient Greeks, Romans, Arabians, Chinese, and Egyptians. Among the drugs then used were mandragora, belladonna, hyoscyamus, and cannabis indica; later opium and alcohol were added to this list, and in fact ancient therapy was not dissimilar to ours up to the middle of the nineteenth century. Not only did the ancient physicians employ decoctions and infusions of drugs to alleviate pain, but they realized that the therapeutic action of these agents could be obtained by the inhalation of the fumes from burning herbs. They also possessed some crude knowledge of physiology and pathology. They knew that anemia of the brain prohibited to a greater or less extent the functionating capacity of the cerebral centers, and employed compression of the carotid arteries to obtain a lessened sensibility during operative measures. They also advocated bleeding the patient until syncope resulted to alleviate the agonies of surgery. Pressure on nerve trunks, whose terminals innervated the field of operation, was next resorted to as a means of reducing pain. Hypnotism or mesmerism was next tried. This innovation was suggested and employed my Friederich (or Franz) Anton Mesmer (1735-1815), a German physician, who because of his studies in astrology at first claimed to cure disease and alleviate pain by means of magnets. Later, however, he professed to accomplish the same ends by an inherent animal magnetism he possessed. Leaving Germany he went to Paris where he elicited intense interest. The Academy of Sciences of that city appointed a committee including Benjamin Franklin of this country to investigate his methods. The report was unfavorable to Mesmer. Discouraged he went to London, finally returning to Germany, where he died.

The historical data concerning our modern anesthetics are somewhat confusing, inasmuch as different authorities accredit the *original discovery* of nitrous oxid and ether to different individuals, besides varying as to dates. The research I have made, however, I think justifies the following conclu-

sions: Valerius Cordus discovered ether in 1540. Joseph Priestley (1733-1804), an English physicist and Unitarian divine, in 1774 discovered among other gases, oxygen and nitrous oxid. He was a man of letters and science; took an active part in the public questions of the day, and was very outspoken in his ideas on theology. The stand he took on these subjects aroused much bitterness and animosity. Other characteristics show him of a forgiving nature, and possessing the greatest liberality toward those who did not accept his views. Desiring to remove from the scenes of argument and strife with which he was surrounded he left England for America and settled at Northumberland, Pennsylvania. As is usual with such brilliant characters his true worth was not recognized until long after his death. The city of Birmingham, England, erected a marble statue of him in 1874.

It is a peculiar historical fact that the discovery of nitrous oxid and oxygen was made by the same man and followed in quick sequence, and that even after the anesthetic properties of nitrous oxid were thoroughly appreciated by the profession its field of usefulness was limited until, by the addition of oxygen, its range as an anesthetic became unlimited. The mixture of these gases was first suggested and utilized by Dr. Edmund Andrews of Chicago in 1868.

Samuel Guthrie (1782-1848), an American chemist, discovered chloroform in 1831.

The discovery of nitrous oxid and ether did not add much to the therapy of the profession at that time, nor for years after. The effects of these drugs on the economy were only partially understood. Inhalation of ether was advised to relieve the suffering of tuberculosis, the spasmodic condition occurring in asthma, and other painful affections. Perira in 1839 in his work on "Materia Medica" counseled the danger of allowing a patient to inhale too much of the vapor of ether *because of its stupefying effects.* Sir Humphrey Davey (1778-1829), an English chemist, employed nitrous oxid to *annul the pain of toothache,* and in 1798 suggested its use as a means of relieving suffering in surgical operations. In addition experiments were made by the profession on the lower animals both with nitrous oxid and ether, yet with the clinical experience they possessed of the narcotic effects of ether and nitrous oxid, together with the results of their experiments on the lower animals, it seems incredible that the investigators of those days overlooked the anesthetic properties of these drugs.

Nitrous Oxid.—An itinerant scientist named G. Q. Colton (1814-1898) visited Hartford, Connecticut, December 10, 1844, and delivered a lecture on the same evening. One of the audience who had taken nitrous oxid for its exhilarating effects, fell and injured his leg without *experiencing any pain.*

Horace Wells (1815-1848), a dentist of the same city, witnessed the incident, and *immediately conceived the idea of using nitrous oxid as a means for relieving pain during the extraction of teeth.* He was so firmly convinced of the usefulness of the gas under such circumstances that he persuaded Colton to administer it to him the following day, at which time he had a tooth *painlessly extracted.* After successfully using it in his dental work, he obtained permission to demonstrate its efficacy at the Massachusetts General Hospital, *but on account of an insufficient amount of gas anesthesia was not produced.* Nitrous oxid then fell into disuse until 1863, when Colton induced dentists to utilize the gas. Four years later Colton published a record of 20,000 cases of successful anesthesia. To Wells therefore is attributed the honor of having first demonstrated the anesthetic properties of nitrous oxid.

Ether.—The discovery of ether as an anesthetic is conceded to Dr. Wm. T. G. Morton (1819-1868), an American dentist. Morton was a student of Horace Wells, and afterwards became his partner in Boston. During his association with Wells he recognized the advantages derived from nitrous oxid as an anesthetic in dental surgery. On the dissolution of the partnership Morton requested Wells to disclose to him the methods he employed to manufacture nitrous oxid. Wells, who apparently had kept his process a secret, referred him to Dr. C. T. Jackson (1805-1880), a physician, but better known as a scientist, who had been associated with them. Jackson suggested to Morton the substitution of ether for nitrous oxid because of the facility with which the former could be made. Morton, acting on this suggestion, obtained some ether (history is not clear whether Jackson manufactured it or not), and on September 30, 1846, painlessly extracted a tooth. The period of unconsciousness was so prolonged, however, as to alarm Morton, and for some days he discontinued his experiments. *On the memorable day of October* 16, 1846, *at the Massachusetts General Hospital, Morton successfully aministered ether to a patient from whom Dr. J. C. Warren* (1778-1856) *removed a tumor from the neck.* Unfortunately, Morton, thinking only of self-aggrandizement and financial gain, combined aromatic oils with the ether to disguise it, and claimed for it the proprietary name of "Letheon." This unethical procedure prejudiced the profession against its use. The true nature of the anesthetic was soon suspected, and Morton admitted its identity.

To complete the historical record of this anesthetic I must mention the name of Dr. Crawford W. Long (1816-1878) of Jefferson, Jackson County, Georgia, who in 1842 (four years previous to Morton's discovery) successfully administered ether as an anesthetic and removed a tumor from the jaw of a patient. He appears to have subsequently employed this drug in his

ILLUSTRATION LVI

The Anesthetizing-room.—Note the large entrance into the operating-room which facilitates the moving of the patient to the surgery. See illustration XLIII for the relation of this room to the operating-room.

surgical work. Unfortunately for Long as well as for humanity, he did not realize the immense scope of his discovery, but kept the results to himself and did not publish them *until Morton's achievements became public.* I think Dr. Long clearly demonstrated his claims as to priority. Inasmuch as Morton made his discovery public, history accredits Morton the honor which he deserves. The controversies that ensued between Wells, Morton, Crawford, and Jackson as to the part each played in the discovery of the anesthetic properties of nitrous oxid and ether form one of the darkest chapters in surgical literature. Time I think has made the following deductions:

Dr. Crawford W. Long *was the first to use any drug for the definite purpose of producing anesthesia,*—this he accomplished with ether on March 30, 1842. His discovery was not published until some years later.

Dr. Horace Wells, a dentist, on December 11, 1844, persuaded a chemist by the name of Colton to administer nitrous oxid to him for the *purpose of having a tooth painlessly extracted, with successful results.*

Dr. W. T. G. Morton, a dentist, *successfully produced anesthesia with ether for the extraction of a tooth* September 30, 1846, and on October 16 of the same year *made a public demonstration of the efficacy of ether* as an anesthetic at the Massachusetts General Hospital.

Dr. C. T. Jackson, a physician and scientist, first suggested the use of ether to Morton.

Chloroform.—On account of improper inhalers, and possibly through fear in its administration, the anesthetic effects of ether were not uniformly obtained; the consequence was that the leading surgeons of Great Britain were not very enthusiastic in its adoption. Possibly on this account Sir James Young Simpson (1811-1870) of Edinburgh, Scotland, endeavored to find a substitute. It is unanimously agreed that a chemist of Liverpool, England, by the name of Waldie, suggested chloroform to Simpson. Simpson experimented with this drug on himself and others at his residence, with successful results, November 4, 1847. The first surgical operation made under the influence of chloroform was performed at Edinburgh, November 15, 1847.

The Field of Application of Anesthetics.—At the present time general anesthesia is not limited to surgical operations, where it plays the important part in relieving pain, abolishing consciousness, and obliterating psychical effects on the patient, but its use is extended to other realms. In the diagnosis of obscure abdominal and pelvic conditions the aid of an anesthetic is frequently required to permit a more thorough examination. Anesthesia plays an important part as a means of differentiating between a true ankylosis or an assumed stiffness of a joint in that class of individuals who are anxiously awaiting an opportunity to demand remuneration for some supposed damage.

Frequently by this means the surgeon is able to distinguish the malingerer from the honest claimant. Anesthesia is advisable in the reduction of fractures and dislocations to relax muscular tension and permit a more thorough manipulation of the injured member. The differential diagnosis between hysteria and organic lesions of the brain and cord may be made by administering a sufficient amount of anesthetic to produce partial unconsciousness. In obstetric practice it certainly is a blessing to the prospective mother.

Mixed Anesthesia.—By this term is understood the hypodermatic administration of narcotic drugs, such as morphin, atropin, hyoscin (scopolamin), or a combination of morphin with either of the other drugs an hour or two previous to the administration of a general anesthetic. (See sections in this lecture on "Anesthetic Mixtures" and "Anesthetics in Sequence.") The philosophy of the use of these narcotics has been briefly mentioned in the lecture on the "Preparation of Patient for Operation." Some surgeons dispense with the use of these drugs as a pre-anesthetic measure because of certain disadvantages they claim follow their use; as excessive depression is developed, anesthetic stupor prolonged, body-temperature lowered, the liability of respiratory failure increased, etc. These operators fail to comprehend that by the use of these drugs advantages are obtained which more than offset their disadvantages, besides the objectionable effects, if any, are due in most cases to faulty technic in administering the anesthetic. But even the most ardent advocates of mixed anesthesia did not grasp the far reaching and beneficial effects produced by these drugs until Dr. Geo. W. Crile demonstrated in his usual scientific and convincing manner that *certain changes were produced in the cerebral cells of a patient by psychic effects endured previous to operative interference and traumatic impressions suffered during an operation.** The changes which occurred in the brain-cells from these two causes so lowered or reduced the vital force of the subject as to increase surgical risk. One of the most prominent psychic factors which induces such changes in the cerebral-cells is *fear with its concomitant emotional disturbances.* "Fear is stronger than the will," as Crile tersely states it. Regardless of efforts at self-control, fear unchecked and untrammeled develops under certain conditions, until such deleterious changes are made in the brain-cells as to permit of their eliminating nervous energy to an abnormal extent. *The patient is thus handicapped before a step is taken in the surgical ordeal.* The amount of fear which develops in patients of course depends on individuality. The subject with a naturally susceptible temperament, impressionable nature, and imaginative mind becomes an easier prey to fear, and the changes wrought in the cerebral-cells in such patients will be proportionately greater

* The reader is referred to an article written by Dr. Crile (Journal American Medical Association, Dec. 2, 1911), "Newer Methods for Further Increasing the Safety of Surgical Operations."

than in those of an opposite temperament. By the use of narcotics administered as a pre-anesthetic measure, the *subject is placed in a quiescent state, irritating psychic effects are abolished, and thus the cerebral centers are protected and the vital force of the patient conserved.* In other words the surgical risk is diminished.

Dosage.—The amount of morphin and hyoscin (scopolamin) or other combination narcotics which should be administered as a pre-anesthetic step must correspond with the temperament and physical condition of the patient. This is an essential that is frequently overlooked. The common practice of ordering a routine amount for every case should not be countenanced. For instance, the impoverished anemic woman will be sufficiently fortified by morphin gr. 1/8 and hyoscin (scopolamin) gr. 1/200, while the full-blooded and muscular man would require double this amount to produce similar effects. Furthermore, it is often advisable to divide the maximum dose which is to be given into fractional doses administered hourly, that is to say, if morphin gr. 1/4 and hyoscin (scopolamin) gr. 1/100 is the amount considered necessary to place the patient in a quiescent state, I am convinced that a better effect is obtained by giving morphin gr. 1/8 and hyoscin (scopolamin) gr. 1/200 two hours before the time set for operation, and a similar dose an hour before the patient is sent to the surgery. By this means a longer interval of cerebral-rest is obtained than if the whole amount was injected two hours previous to operative interference, because at the end of this period the physiologic action of the drug would be passing off and fear would increase proportionately as the anticipated time approached. If the total amount were injected an hour before the anticipated operation the cerebral-cells would be fatigued up to the time the injection is administered. A very short interval of brain rest is thus given. While the number of cases in which I have used this fractional method in my clinic is limited, both my anesthetist and I feel that a progressive step has been made.

Local Anesthetics Employed Contemporaneously with General Anesthetics.—When the patient is under normal surgical anesthesia produced by *ether or chloroform sensibility to pain of course is abolished, but the cerebral-cells are only diminished or obtunded in their activities, and are capable of receiving and recording external stimuli.* Crile demonstrated that the *effects of traumatism incident to surgical operations were carried to the brain-cells and produced such changes in them as to reduce vital force and thus further handicap the patient.* To prevent these impressions from reaching the brain, *dilute solutions of local anesthetics* are injected either in the field of operation or in the nerve supplying the area of surgical interference. The nerve endings being thus anesthetized, impressions which would be carried to the brain-cells are blocked, and the vital force in this way conserved. Besides

which, *a smaller amount of the general anesthetic is required,* which is another item in the conservation of the patient's resistance.

When nitrous oxid-oxygen is the anesthetic employed the condition is somewhat changed. The cerebral-cells depend for their functionating ability on *a normal amount of oxygen.* Inasmuch as nitrous oxid displaces the normal amount of oxygen, the brain-cells are inhibited in their function *in proportion to the deficiency of oxygen.* Receptive impressions are therefore

ILLUSTRATION LVIa

Method of administering a Local Anesthetic. Observe the syringe is held parallel with the part to be anesthetized and the needle penetrates the skin only, not the subcutaneous tissues. Note the wheal produced by the infiltration of the solution as is shown by the white line on the surface. The needle employed should be long and fine. The usual steps in sterilization must be made before infiltrating the anesthetic solution. Compare this technic with the hypodermatic administration of morphin, etc., as seen in illustration XVIa.

minimized and the dischargeable nervous energy from the nerve-cells curtailed. Hence by the use of nitrous oxid-oxygen the brain-cells are protected to a greater or less extent from the traumatism of the operation, and the vital force of the patient proportionately increased. The combination of nitrous oxid and oxygen, however, permits the cerebral-cells *to retain some oxygen within themselves* and hence some impressions do reach the centers. To off-

set which local anesthetics are utilized in the field of operation to block any impulses that may be received by the *partially incapacitated cerebral-cells.* The physiologic effects of nitrous oxid and oxygen are very transient, so that the employment of local anesthetics also dulls the sharp edge of pain in the operative field *after* surgical interference.

Local Anesthetics Commonly Used—Strength of Solution.—Novocain or cocain are certainly preferable to any others, and are generally used in a one-fifth- to one-fourth-per cent. solution. The suggestion which has been made of using quinin and urea hydrochlorid as a substitute for the above drugs because of its long lasting anesthetic effects may prove worthy of trial in *dilute solution* (one-eighth to one-fourth per cent.), but the experience of the writer with the use of this anesthetic in minor operations, such as amputations of the digits, or any location where the skin is involved, prohibits his recommending it for this purpose, because of the slough which follows the injection of a *one-per cent.* solution. These solutions should always be made with sterile normal saline solution, and not plain sterile water.

Anesthetic Mixtures.—By this term is understood combinations or mixtures of chloroform, ether, and other drugs. At the present time their use is very limited, and practically dispensed with in this country. Among such combinations may be mentioned the A. C. E. mixture, the formula of which is as follows:

Alcohol..........	one part	by volume
Chloroform.......	two parts	
Ether............	three parts	

The C. E. Mixture:

Chloroform.......	two parts	by volume
Ether............	three parts	

I have mentioned these combinations simply to complete the text of the subject; they are not recommended.

Anesthetics Administered in Sequence.—Under certain conditions it occasionally is beneficial to start with one anesthetic, and subsequently change to another drug to maintain and complete the anesthesia; this is known as *anesthetics in sequence.*

Various conditions may arise which make this method of producing anesthesia appropriate, as in *cases of alcoholics,* or in *those patients addicted to drug habits* who are prone to be excitable and difficult to bring under the influence of the anesthetic of choice. In such cases chloroform is generally employed until unconsciousness is obtained, followed by some other anesthetic.

The irritating effects of ether on the respiratory mucous membrane when first administered make it advisable frequently to utilize chloroform at first to be followed by the administration of ether; or nitrous oxid may be substituted for chloroform.

When nitrous oxid-oxygen has been selected as the anesthetic a small amount of ether may be added *during the administration of the gas* to overcome some deficiency in the effects of the nitrous oxid, after which ether is stopped and the nitrous oxid-oxygen anesthetic continued alone. Technically this is really an anesthetic mixture, because there has been no interruption of the nitrous oxid-oxygen administration, but simply an addition of a small amount of ether. The more expert the anesthetist becomes in the administration of nitrous oxid-oxygen, the less use will there be of ether.

Preparation of the Patient.—A systematic preparation of the patient who is about to be anesthetized is only another of the many modern refinements, I should say safeguards, which have been added to the technic of surgical procedures. The well educated and conscientious surgeon before advising his patient to submit to a surgical operation, takes into account not only the disease for which he is consulted, but carefully investigates the general physical condition of the patient. He immediately decides by this examination if the patient is capable of withstanding surgical interference and its concomitant anesthesia. If his opinion is favorable for an operation, *the physical examination becomes really the first step in the preparation of the patient for an anesthetic.* In well-regulated hospitals further examinations are made the day previous to an operation to *confirm* the physical condition of the patient. The diet is regulated; the drinking of large quantities of water encouraged, and efforts are made to stimulate the excretory organs of the body to their full capacity, besides paying attention to the toilet of the mouth,—*the reasons for all of which have been detailed in my lecture on the "Preparation of Patient for Operation."* The clinical laboratory at the present time has become a necessity to the modern surgeon. This department makes the chemical and microscopical examinations of the urine, from which deductions are made as to the functionating capacity of the kidney and occasionally reveals the presence of diabetes, or some other abnormality which was not suspected. It also furnishes the report of the blood examination, from which the surgeon ascertains the amount of natural resistance the patient possesses; besides it indicates if destructive changes have been produced in the blood by the disease from which the patient suffers; a record of the blood-pressure is made and affords knowledge as to any degenerative changes occurring in the heart and blood-vessels;—all of which directly or indirectly play a part in the preparatory treatment of a patient for an anes-

thetic. Moreover the *choice of an anesthetic* is frequently determined by the clinical reports of the condition of the kidney, the amount of blood-pressure, and the result of the blood-examination.

In order to emphasize the preparation a patient should receive previous to being anesthetized I take the liberty of repeating, not only the suggestions given in this lecture, but also referring to such steps as bear on this subject in the lecture on the "Preparation of Patient for Operation."

A thorough physical examination of the patient is imperative.

On the day previous to operation the following routine is carried out:

(1) Clinical laboratory reports are made of the urine, blood, blood-pressure, etc., to confirm the physical examination.

(2) A properly selected diet is chosen. The administration of food should cease six hours before the time set for operation.

(3) The patient is encouraged to drink large volumes of water as a urinary stimulant, which should be discontinued at least three hours before the administration of the anesthetic.

(4) Properly selected cathartics are administered to relieve the bowel of fecal accumulations.

(5) The cleansing of the patient's mouth and teeth is accomplished by the frequent use of the ordinary toothbrush and some alkaline antiseptic wash to remove infectious debris which may be inhaled during the administration of the anesthetic, and in operations on the stomach it lessens the liability of infection from this source. This toilet should be repeated just before the patient is taken to the operating-room.

On the day of the operation the following is the schedule:

(1) Rectal enemata are usually administered four hours previous to the time set for operation.

(2) A hypodermatic injection of morphin-atropin or morphin-hyoscin is given a half hour to two hours previous to the administration of the anesthetic. (Some surgeons use the former combination, others employ the latter formula, while a third class of operators dispense with these drugs altogether.)

(3) Before being taken to the operating-room the patient is either permitted to empty the bladder, or if necessary catheterized.

(4) As a final step remove all artificial plates of teeth—the nurse takes care of these. Some anesthetists prefer allowing a patient who wears a complete upper and lower plate to retain them in place during the anesthetic, claiming a freer respiration is thus afforded and that the size of the plates prevent them from being swallowed. The nurse should know the anesthetist's views on the subject.

Modifications in the Preparation of the Patient—Emergencies.—In my lecture on "The Emergency Operating-room" I have outlined the manner in which the sufferer's clothing is removed and the hospital gown substituted. In this class of cases time is an important element. Nevertheless, it is imperative to ascertain the condition of the patient's lungs, heart, and blood-vessels. Gastric lavage is indicated, unless a penetrating wound of the stomach is suspected, under which circumstances it is omitted. In accident cases where hemorrhage has depleted the patient, or shock is present, no time is to be lost in this preparatory step. These complications should be immediately met by transfusion, which is the only preparatory measure that insures safety to the patient from the further depressing effects of the anesthetic and operative measures. Transfusion in these cases becomes a lever by which defeat is changed into victory and a state of dissolution transformed into one of natural resistance. Since Crile demonstrated the increased body-resistance which can be obtained by transfusion in such cases, every advanced surgeon has confirmed his views by his own clinical experience. Emergency patients who are totally unfit to receive an anesthetic and undergo an operation are thus rendered practically immune against the deleterious effects of the drug and the harassing effects of the necessary operation. Leonard Hill demonstrated that when the blood-supply to the central nervous system is below par chloroform (*as well as other narcotic poisons*) affect the centers of vitality more readily; *that the ordinary amount of anesthetic* which can be administered when the blood-pressure is normal, *will prove fatal in a blood-pressure which has declined.* Moreover the whole vascular system becomes so affected that the blood drains from the arterial system into the large abdominal veins. This statement, emanating from such an authority as Hill, in conjunction with Crile's demonstrations, should be prima facie evidence *of the necessity of transfusion as a preparatory measure to anesthesia in emergency cases suffering from shock or hemorrhage.*

The administration of strychnin, digitalis, etc., plays a very minor part as a stimulant under these conditions. The transient stimulating action of an intravenous infusion of normal saline with adrenalin chlorid is a poor pre-anesthetic measure as compared with transfusion for the unfortunate class of whom we are speaking. Nevertheless circumstances may compel its use. (See lectures on "Surgical Shock" and "Transfusion—Infusion.") Moreover, Crile has demonstrated that transfusion is the preparatory measure to be instituted on those patients whose general health has been so undermined by disease as to render them unfit subjects for an anesthetic and its concomitant operation. Therefore *transfusion should be recognized as a neces-*

sary step in the preparation of the patient for an anesthetic whose vitality has been suddenly reduced by an emergency, or whose resisting power has been depleted by disease.

The Anesthetizing-room.—This room should be light, cheerful, and kept to the highest standard of cleanliness. Everything should be prepared and in its place so as to impress the patient with the orderly manner in which details are carried out. It should communicate with the operating-room by a large doorless opening to facilitate moving the patient to the surgery when anesthetized. (See illustration LVI.) The furniture should be of the simplest kind and consist of such articles as are necessary. The following is the equipment:

(1) An ordinary wheel car or stretcher for transporting patients from their room to the anesthetizing-room.

(2) An anesthetizing-stand similar to the one used in the operating-room, equipped with the following (when in use)—

(a) Anesthetics (ether and chloroform).
(b) Tongue forceps.
(c) Mouth-gag.
(d) Inhalers and cones which are *cleansed and sterilized after each administration.*
(e) Hypodermic syringe equipped and filled with some heart stimulant.
(f) An atomizer filled with a solution of cocain (4 per cent.).
(g) Face demulcent.
(h) Sterile rubber dam to protect the patient's eyes.
(i) Anesthetic charts.
(j) Sterile towels.
(k) Pus basin.

(3) One complete apparatus for the administration of nitrous oxid and oxygen, together with extra tanks of these gases.*

(4) One aseptic cupboard in which are stored ether, chloroform, etc., anesthetic charts, cones, inhalers, sphygmomanometer, and such other articles as come under the supervision of the anesthetist. This cupboard should be kept locked.

(5) One metallic stool for the anesthetist.

(6) One metallic closet with perforated shelves, heated either by steam or the more modern electrical warmer. The blankets and gowns for patients' use after operations are stored in this.

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* When nitrous oxid-oxygen is employed, the patient is anesthetized in the operating-room and this apparatus is removed to the surgery.

The Anesthetist.—Self-confidence is a characteristic that every anesthetist should cultivate. While sympathy and kindness are necessary attributes, there should be that firmness and decision of character which will impress the patient that the anesthetist is perfectly familiar with the necessary details.

The toilet of the anesthetist should be as esthetic as the duties to be performed will permit. Proper uniforms and headcovering should be assumed and possibly a face mask, if this is required by the surgeon. Attention should be paid to the cleansing of the hands and manicuring of the nails. In operations on the face and within the cranium the anesthetist should make a *sterile toilet* and endeavor to maintain it during operative procedures in order to prevent contamination of the field. The anesthetist should be provided with a watch to accurately record the pulse and respiration, the watch should be located where it can easily be seen to make the necessary observations. Occasionally as in cranial or hazardous operations, the sphygmomanometer is utilized to determine the patient's blood-pressure during the surgical procedure. To observe the readings of this instrument an assistant is designated especially for this purpose.

Statistics.—Chloroform, Ether, and Nitrous Oxid-oxygen are the only anesthetics I shall call to your attention because I believe they are the only drugs known at the present time worthy of consideration in this special field. I desire to impress on you that the ideal anesthetic has not been discovered. Since Morton demonstrated the efficacy of ether as an anesthetic the profession has been endeavoring to find some drug or combination of drugs which would fill the necessary requirements for anesthesia without the disadvantages which all our modern anesthetics possess to a greater or less extent; so far with negative results. All anesthetics have to their credit a certain death-rate. Correct statistics cannot be obtained as to the mortality attached to the three drugs of which we are speaking, because the dangers accruing to a patient under the influence of an anesthetic depend to a great extent on the experience and personal equation of the anesthetist. By this I mean not only the deaths that immediately occur when the subject is under anesthesia, but the injurious effects which play a greater or less part in the deaths occurring later. In order to give you an approximate idea as to the fatalities connected with chloroform, ether, and nitrous oxid I shall cite Dr. Hobart A. Hare's statistics as given in Keen's Surgery:

Chloroform....	one death in	2,500 anesthetics
Ether..........	one death in	16,000 anesthetics
Nitrous Oxid..	one death in	200,000 anesthetics

Statistics vary with different authorities, but the foregoing I think are sufficiently correct for our purpose. They portray to the mind at least the relative dangers of each of the drugs.

Chloroform—*Physical and Chemical Properties.*—Chloroform is a clear, colorless, heavy fluid with a specific gravity ranging between 1.490 and 1.497 at 62.5°F. It possesses a characteristic odor. Its vapor is not inflammable, but in the presence of an open fire the vapor is decomposed, forming fumes which *are exceedingly irritating to the respiratory tract.* (See lecture on "Major Surgery in Private Practice," section "Preparation of the Extemporized Operating-room.") It is easily decomposed by heat and light, and hence should be kept in a cool room in small dark-colored containers. The common practice of purchasing this drug in one-pound bottles and using therefrom as necessity demands is wrong. When chloroform is evaporated on a watch glass no residue or odor of the drug should remain. It is a powerful solvent for fats. The reaction of this drug should be neutral to litmus paper.

The Effects Produced by the Inhalation of Chloroform—The Cerebro-spinal Nervous System.—The action of chloroform on this system depends on the amount of the drug inhaled. The activity, sensibility, and motility of the different portions of the cerebro-spinal system are decreased, obtunded, or diminished in the following sequence.

(1) Perceptive centers in the posterior cerebral convolutions.
(2) The intellectual centers in the anterior or frontal convolutions.
(3) Motor areas of the cortex.
(4) Sensory tracts in the cord.
(5) Sensory portions in the medulla.
(6) Motor portions of the cord and medulla.—HOBART A. HARE.

When these latter motor portions are affected the amount of anesthetic administered is far in excess of that which is necessary for surgical anesthesia. Further administration of the drug will entirely obliterate the vital centers located in the medulla.

Heart and Circulatory System.—From the anesthetist's standpoint the effects of chloroform on this system are of paramount importance. This drug produces a *direct depressant action on the heart muscle,* resulting in the loss of its expulsive force, and sooner or later causing dilatation. Its effect on the vasomotor center is one of depression. The normal control possessed by this center on the vasomotor nerves which regulate the caliber of the blood-vessels is therefore handicapped. A relaxation of the entire vascular system occurs and results in *lowered blood-pressure.* The coronary arteries which supply the heart muscle with nutrition and stimulation suffer in proportion to this reduction in blood-pressure. The consequence is, the amount

of blood carried by these vessels is not sufficient to maintain cardiac physiology, so that the heart is suffering from the *direct effects of the drug, plus a lack of nutrition and stimulation.* If the administration of chloroform is carried to an unnecessary extent the circulation is still further impoverished by a greater reduction of blood-pressure—the result of the exhausting effects on the vasomotor center, and a condition is developed that simulates one of surgical shock.

The Respiratory System.—One of the necessary requirements for any organ to possess, in order for it to perform its function physiologically, is a normal circulation. This is especially true of the vital centers. When the blood-current has been reduced in volume and its pressure decreased to an abnormal point from the effects of chloroform, *the respiratory center* suffers because of the subnormal circulation. The consequence is the respirations become weaker and more shallow, and sooner or later give evidence of failure. If administration of the drug is continued paralysis of the respiratory center follows—the result of decreased blood-pressure. *Thus it can be seen that the effect of chloroform on the respiratory apparatus is secondary to its effect on the circulatory system;* furthermore, if close attention is paid to the respiration of a patient under the influence of this drug, deductions can be made as to the condition of the circulation. While the effect of chloroform is irritating to the mucous lining of the respiratory tract, it is by no means as much so as ether.

The sudden deaths which are occasionally witnessed during the administration of chloroform, can be attributed to a heart whose musculature is handicapped by some preëxisting degenerative process, and which only needs the depressing influence of the anesthetic to produce a fatality.

Sudden deaths may also occur *immediately the administration of chloroform is begun, and before a sufficient amount has been inhaled to produce any depressing effects.* There are three factors I think responsible for this accident—

(1) Intense fear of the anesthetic on the part of the patient.

(2) A reflex action causing cardiac inhibition, the result of vagus irritation.

(3) A degenerative process in the heart muscle.

The Blood.—Chloroform has been shown by DaCosta and others to produce changes in the blood. Destruction occurs in the red blood-corpuscles, their shape is changed and hemoglobin diminished, and hence anemia is produced. The temperature of the body is lowered, and the natural resistance of the economy reduced.

The Kidneys.—The action of this drug on these organs is to cause irritation. The amount of chloroform necessary to produce surgical anesthesia, however, should be insufficient to cause deleterious effects.

The Liver.—Chloroform is supposed to have a selective action on the hepatic structure; causing degenerative changes similar to those seen in acute atrophy, while other observers report a condition of fatty degeneration as the result of chloroform anesthesia.

The Skin.—Chloroform acts as an irritant to the epidermis: this should always be borne in mind during its administration.

Indications and Contraindications for the Use of Chloroform.—This drug should not be used when there is degenerative changes in the heart muscle. In cardiac dilatation and valvular disease of the heart chloroform should not be employed unless compensation has been thoroughly restored. When the circulation is weak the depressant action of this drug certainly eliminates it as the anesthetic of choice. In arterial sclerosis, with its accompanying increased blood-pressure (providing cardiac compensation is established), or where aneurism is present, chloroform is used. In the respiratory tract in the presence of chronic bronchitis, pulmonary abscess, tuberculosis, and in some cases of emphysema and asthma, this drug is utilized because it is less irritating to the mucous membrane. When pronounced emphysema or chronic asthma has been present for a sufficient time to dilate and weaken the muscular structure of the heart, the choice between chloroform and ether is a difficult problem to solve; no fixed rules can be given. In operations on the throat and mouth, especially in children, chloroform by general consent is the anesthetic most frequently utilized, but the flat recumbent position must be maintained. In cases requiring the use of the cautery chloroform is preferable to ether because of the imminent danger of an explosion occurring from the ether fumes. In operations on the kidney, or in other operations in which there is present degenerative processes in the structure of the kidney, especially in acute nephritis, chloroform is indicated because it is less irritating than ether on these structures volume for volume. In anemic and debilitated patients, or in cases suffering from a general infection, the use of chloroform is contraindicated. In the numerous industrial accidents accompanied with shock or severe hemorrhage, as well as in operations which will consume a long period of time and in which shock or hemorrhage is anticipated, chloroform has no claim as an anesthetic. In obstetric practice it is universally used, excepting, possibly, what may be termed surgical obstetrics. Chloroform is contraindicated as an anesthetic in diseases of the liver.

The Administration of Chloroform.—The following anesthetic form as will readily be seen is *gradually compiled.* Such forms impart valuable information, not only during the operation and immediately afterwards, but statistics gathered from properly kept anesthetic slips are of the greatest benefit for future reference. They also serve as evidence in medico-legal questions as to the care or lack of care a patient received during the administration of the anesthetic.

Chloroform-ether Anesthetic Slip.—

Name of patient....................................
Room number ....
Anesthetic used ....
Pulse ....Respiration.........(Before anesthesia)
Anesthetic started ....
Anesthetic completed ....
Operation started ....

TIME	PULSE	RESP.	TIME	PULSE	RESP.

Anesthetic ended ....
Operation ended ....
Pulse ....Respiration..........(After operation)
Amount of oxygen used.............................
Amount of anesthetic used..........................
Hypodermic medication used.........................
Saline infusion......Amount......How employed......
Packing or drainage used..........Where..............
Character of the operation..........................
....
....
Anesthetist ....
Date ....

Preliminary Steps.—

The place of administration—anesthetizing-room.

Choice of location—operating-table.

Posture—flat recumbent, head slightly lowered.

(1) Observe if the patient is sufficiently covered to maintain body-temperature.

(2) Ascertain if false teeth have been removed, or if any foreign body is in the mouth.

(3) Cocainize nares and pharynx to prevent irritation of the nerve endings of the upper respiratory tract by the anesthetic.

(4) Apply demulcent to the face to prevent irritation from the drug.

(5) Instruct the patient to breathe naturally, and *under no circumstances follow the common practice of suggesting to the patient to take deep inspirations,* as in this way an excessive dose of the anesthetic will be inhaled; such deep inspirations, together with the unnecessary amount of the drug inhaled, irritate the nerve-endings of the upper respiratory tract and tend to produce inhibition of the cardiac and respiratory systems.

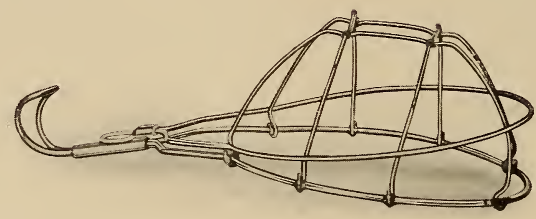

ILLUSTRATION LVII

An Esmarch Inhaler.—Thin flannel, stockinet, or gauze is stretched over the wire frame and held in position by the wire clamp shown in the illustration.

(6) Protect the eyes of the patient by a piece of rubber dam or folded towel. Explain to the patient the reason for such a step.

(7) After the intellectual centers are sufficiently obtunded secure the patient's hands by the method usually employed, not before this stage is reached, because it has a tendency to produce fear and opposition on the part of the subject.

The Inhaler.—The Esmarch is the simplest form of inhaler and consists of a wire frame over which is stretched a layer of thin flannel or stockinet.

(See illustration LVII.) It has been demonstrated that the coarser the weave of the material which covers the inhaler the more rapid is the evaporation and the greater is the dose of the drug received by the patient,—a point to be remembered. In private practice a folded handkerchief or napkin is frequently used as a substitute for the inhaler. Another simple form of inhaler is seen in illustration LVIII.

The Chloroform Container.—Any ordinary bottle with a stopper which will permit a gradual dropping of the drug is all that is necessary. Another simple means of facilitating the administration of the drug by the drop

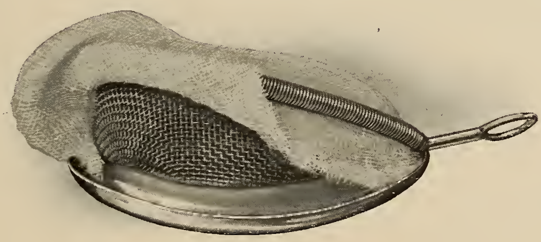

ILLUSTRATION LVIII

An excellent inhaler. It is prepared for use in the same manner as the Esmarch Inhaler.

method is afforded by cutting a V shape channel in the cork of the chloroform container and inserting into this groove a wick of twisted absorbent cotton or gauze.

The Inhalation.—

(1) Hold the inhaler one-half inch from the face.

(2) Drop the chloroform at the rate of eighteen to twenty drops per minute on the inhaler. This will give about a one- to one and one-half per cent. mixture of chloroform.

(3) Observe the respirations by watching the respiratory action of the thorax and listen to the force of expiration. Note the rate and character of the pulse by palpation of the temporal or facial arteries; if this latter vessel is utilized for this purpose as it passes under the angle of the lower jaw the palpating hand can also hold this member upward and forward, and thus permit a free access of air. During surgical anesthesia when muscular re-

laxation is present the head has a tendency to fall forward and thus constrict the larynx.

(4) If the respirations continue smooth and their rhythm normal, the inhaler *may be slightly lowered on the face, thus gradually concentrating the chloroform vapor, but still permitting a free access of air.* Approximately this will afford a two-per cent. mixture of chloroform, *which is the maximum mixture to be inhaled.*

(5) Pay close attention to the pupils, which at the beginning of the administration of the anesthetic are somewhat dilated, but as the anesthetic state is approached contraction of the pupillary orifices occurs. A sudden dilatation of the pupil at this stage is an indication of impending danger.

(6) Carefully note the color of the face, ears, and lips. The patient's normal color should always be maintained, any tendency toward cyanosis is at once an indication for the cessation of the anesthetic.

No adverse symptoms arising, the patient will be anesthetized in about ten minutes.

Signs of Normal Surgical Anesthesia.—The respirations are regular and quiet. The pulse is full and the rate possibly slower than when the anesthetic began because excitement is abolished. The color of the face is that which is peculiar to the patient, but under no condition cyanotic. The pupil of the eye is somewhat contracted, the lid-reflex abolished. The muscles are relaxed so that if the arm of the patient is raised from the table it falls helplessly.

After complete anesthesia has been obtained it is frequently possible for the anesthetist to reduce the amount of chloroform, either by decreasing the number of drops per minute, or by raising the mask and causing a greater dilution of the drug.

Untoward Conditions.—If however respiratory spasms occur at the beginning of the administration of the drug remove the inhaler from the face and allow the patient to have a breath or two of fresh air, then continue as before. If the patient becomes pugnacious and struggles, the anesthetic should be immediately suspended until struggling ceases. It is in these cases the uninitiated makes the fatal error of attempting to subdue the patient by increasing the amount of chloroform. It can easily be understood that during such struggles the inspirations are increased in frequency and depth, and hence even though the amount of chloroform is not increased the *amount inhaled is greatly in excess* of what is needed. Added to this is the extra work which

is thrown on the heart during this period of excitement and the depressing influence of the drug on this organ,—a combination conducive to a fatality.

Accidents Occurring During Chloroform Anesthesia.—Circulatory failure is the most frequent accident encountered. This may occur in three ways:

(1) The direct depressant and degenerative action of the drug especially on a heart whose musculature is handicapped by some preëxisting degenerative process. A fatality may ensue under such conditions when the anesthetic is safely within therapeutic dosage.

(2) Cardiac inhibition produced through irritation of the vagus, especially if associated with a diseased myocardium. In this case also the amount of drug administered may be within the bounds of safety *in a subject with a normal heart,* but on account of the degenerative condition of the myocardium the accelerator nerves of the heart cannot overcome the amount of inhibition.

(3) A fatality may occur from a lethal dose of the drug directly affecting the heart muscle and vasomotor center, thus producing lowered blood-pressure, followed by respiratory failure.

Symptoms.—Inasmuch as a diseased myocardium is either directly or indirectly responsible for two of the three ways in which a fatality may occur as the result of circulatory failure and the difficulties encountered in the diagnosis of many degenerative changes associated with the heart muscle, one can easily understand the sudden appearance of alarming symptoms when the patient is apparently in a favorable condition. In most cases there is not the slightest warning, the pulse, which was strong, regular, and of good character immediately before symptoms of circulatory failure appeared, becomes rapid, hardly perceptible, and irregular; the pink color of the face changes instantly to one of a dusky cyanotic character, the respirations become shallow and gasping, the pupils extremely dilated. When circulatory failure is due to a lethal dose of chloroform the symptoms do not make their appearance with the same rapidity, but there is more or less of a period of gradual circulatory decline, followed of course with a proportionate decrease in the respiratory function.

Treatment.—

(1) Cardiac inhibition caused by the irritation of the vagus can be prevented by the administration of pre-anesthetic alkaloids such as morphin and hyoscin. Prevention is better than cure.

(2) Circulatory failure developing, place the patient in the extreme Trendelenberg position if on the operating-table, or in some similar posture if in

private practice, in an endeavor to maintain a circulation around the cerebral centers, as well as to facilitate the emptying of the large abdominal vessels.

(3) Immediately resort to artificial respiration and the administration of oxygen. At the same time massage the heart by pressure and counter-pressure over the thorax in rapid succession. This has been demonstrated to excite cardiac action. If the operation be a celiotomy the heart may be massaged through the diaphragm.

(4) Laborde's method of pulling the tongue forward and downward and then allowing it to fall backward may be tried. These rhythmic movements should be performed sixteen to twenty times per minute.

(5) Intravenous injection of solution adrenalin chlorid 15 to 20 m. should immediately be employed. Intramuscular injections of strychnin sulph. gr. 1/30 may be utilized as well as atropin gr. 1/50; these injections should be given in the upper extremity. The administration of nitroglycerin hypodermatically, or the employment by inhalation of amyl nitrite should not be countenanced because both of these drugs are vasodilators, and only serve to increase the dilatation of the blood-vessels which already exists.

Artificial Respiration—Sylvester's Method.—This is chiefly applicable to women, children, and poorly developed individuals. Where great muscular development is present Howard's method is preferable.

(1) Place the patient flat on the back on the operating-table with the head somewhat lower than the chest, so as to extend the throat.

(2) Pull the tongue slightly forward so as to prevent it falling backward and causing obstruction.

(3) Grasp the arms just above the elbows and firmly compress them against the walls of the chest so as to expel any latent anesthetic.

(4) Have an assistant make upward pressure upon the abdomen below the diaphragm so as to increase the intrathoracic pressure caused by step three.

(5) Slowly lift the arms upward and outward at the same time making traction until they meet above the head. Pause so as to permit all the air possible to enter the lung, then carry the arm to the side of the chest-wall and renew the pressure as in the first step.

The cycle of movements is repeated twelve to sixteen times per minute.

Howard's Method.—

(1) Place the patient flat on the back on the operating-table with head extended so as to prevent any obstruction to the air passages.

(2) Extend the arms above the head and retain them in that position.

(3) Kneel astride the patient.

(4) Place the thumbs on the xiphoid cartilage and apply the hands to the chest-wall so as to grasp the free margin of the ribs, thus compressing the thorax.

(5) Lean forward with the whole weight of the body pressed upward and inward against the diaphragm for a couple of seconds.

(6) Suddenly release the pressure by raising erect, thus relieving the pressure both from below the diaphragm and from the sides of the chest. The cycle of movements is repeated twelve to sixteen times per minute.

Ether—*Physical and Chemical Properties.*—Ether is a clear, colorless liquid, highly volatile, with a pungent odor and burning taste. Its specific gravity should range from 0.720 to 0.713. It boils at 95°F. Its reaction to litmus paper should be neutral. It is miscible in alcohol, chloroform, benzin, etc., but only slightly so with water. It is very inflammable, and its vapor when combined with air explodes violently. According to Buxton "explosion has followed when ether was incautiously held near an electric lamp." It should never be used in close proximity to a gas jet or an open fire, nor in surgical work in which an electric cautery is employed. Ether vapor is heavier than air so that Dr. Hobart A. Hare says in this connection, "it falls to the floor and is present there in a far more concentrated form than the anesthetizer appreciates, and being carried by drafts to a fire in an open grate may cause an explosion. . . . . A number of cases of this character have been reported." As ether readily decomposes when exposed to air, light, and heat, it should be preserved in small dark-colored bottles well stoppered, or in tin containers, and not stored in a warm room.

The Effects Produced by the Inhalation of Ether—The Cerebro-spinal Nervous System.—The immediate action of ether on the brain is one of exhilaration, so that all of the cerebral centers for a short time pass through a stage of excitement. The patient has fanciful ideas, possibly may be talkative or pugnacious. These effects are always present, even though they may not be in evidence. Very soon the anesthetic effects of the drug become dominant. The activity, sensibility, and motility of the different portions of the cerebro-spinal system are decreased, obtunded, or diminished in the same sequence as has been observed from the effects of chloroform, viz.—

(1) Perceptive centers situated in the posterior convolutions.

(2) The intellectual centers situated in the anterior or frontal convolutions.

(3) Motor areas of the cortex.

(4) Sensory tracts in the cord.

(5) Motor tracts in the cord.

(6) The sensory first and then the motor portions of the medulla.

As has been noted in chloroform a dose sufficient to affect the centers in the medulla is far in excess of that which is necessary for surgical anesthesia. When the medullary centers are thus affected the gap between life and death is limited, because the extreme depressant action of the drug has been developed—the amount administered has produced lethal effects.

The Heart and Circulatory System.—Ether when administered to the point of what may be termed *normal surgical anesthesia* stimulates the heart's action and increases its force; at the same time the vasomotor center is likewise stimulated. With the propelling mechanism (the heart) of the circulation increased, and the vasomotor center stimulated to a *point well within the range of what would produce final exhaustion,* the blood-pressure is also raised. But if the amount of anesthetic is increased beyond that which is necessary for surgical anesthesia and maintained at this *abnormal point the depressing effect* of the drug is manifested both on the *heart* and the *vasomotor center,* and the result is a lowered blood-pressure.

The Respiratory System.—The effect of this drug is irritating to the mucous membrane of the respiratory tract, producing hyperemia and causing an excessive secretion of mucus which at times becomes not only annoying, but impedes the administration of the anesthetic. During the early part of the administration of the anesthetic the irritant action of the drug is occasionally manifested on the nerve endings in the upper respiratory tract (trigeminus and vagus), producing a temporary inhibition of respiration, or spasm of the glottis. This condition may lead the anesthetist to consider the possibility of respiratory paralysis. But inasmuch as the physiologic effects of ether is a stimulant to the respiratory center and a lethal dose has by no means been reached, the incident should hardly cause unnecessary anxiety. The respiration at the beginning of etherization is rapid, deep, and stertorous; when the physiologic effect is obtained it becomes slower, but regular. When the anesthetic is pushed to an excess of surgical anesthesia,—in other words, beyond the therapeutic point,—the respiratory center becomes paralyzed. *Respiration generally* ceases before cessation of the heart's action.

The Effect on the Blood.—There is somewhat of a discrepancy among authors as to the effects of ether on the blood, but the research of Evarts Graham undoubtedly is the most careful and scientific that has been undertaken. In his exhaustive investigation he concludes, among other things, that ether *reduces phagocytosis,* and that this reduction in phagocytosis is due to the action of the drug on the serum and leukocytes,—*in other words, ether reduces body-resistance.* The duration of this lowered resistance de-

pends on the amount of anesthetic administered and the physical condition of the patient. Body-temperature is lowered.

The Effect on the Kidneys.—The action of ether on these organs is to cause irritation, possibly not more so than chloroform volume for volume, but inasmuch as the amount necessary for surgical anesthesia is greater than that of chloroform, the irritating effects are increased.

The Effect on the Skin.—Ether is an irritant to the skin, producing vesication providing a rapid evaporation is prevented. When, however, evaporation is assisted and a sufficient amount of ether used, freezing of the skin will be produced.

The Effect on the Eye.—The local effects on the conjunctiva are very irritating. A slight pupillary dilatation is the first change noted from the effects of ether, followed by a contraction. A lethal dose of this drug produces paralysis of the iris with its accompanying dilatation of the pupil,—a point to be remembered.

Indications and Contraindications for the Use of Ether.—At the present time the majority of surgeons, in this country at least, use ether more than any other anesthetic. This is accounted for because, however inaccurate the mortality statistics may be between this drug and chloroform, it is undoubtedly the safer of the two narcotics. Nitrous oxid-oxygen has a mortality twelve to fifteen times less than ether, and but for its deficiencies in certain lines (which of late have been practically overcome) and the necessity for an anesthetist especially trained in its administration, would stand at the head of the general anesthetics. It will eventually, I think, occupy a higher position in this field. Ether is indicated in all weakened conditions of the circulation. In valvular disease of the heart with compensation restored, ether is preferable to chloroform, because of its less depressing action on the circulatory system. In marked degenerative changes in the blood-vessels ether is contraindicated. In spite of the advice of most authorities against the use of ether in surgery of the brain, it is common practice among surgeons to use this drug unless very clear contraindications prohibit its use. While most books on anesthesia, especially those emanating from Great Britain, advise against the use of ether in operations on the thyroid, experience in this country demonstrates its practicability. This is easily accounted for because of the weakened condition of the circulation in such patients; but the subject must be properly prepared by pre-anesthetic alkaloidal narcotics (mixed anesthesia), and the anesthetic administered by an expert. In abdominal and pelvic operations ether has been universally used in this country up to the present time, unless such contraindications as sclerotic arteries or degenerative changes in the kidneys prohibit its employment. In amputations the result of disease or accident ether has always held

a more prominent place than chloroform because of its less depressant action. It is self-evident that this anesthetic is better indicated than chloroform where hemorrhage has been excessive or shock is present, both of which conditions are common in industrial accidents. Reference has been repeatedly made of the contraindication of ether in the various inflammatory conditions of the kidney, and is repeated simply to emphasize the fact. This drug should not be used in operations within the thorax complicated by chronic bronchitis, dilatation of portions of the bronchi, tuberculosis, etc. This phase of the question has been considered under chloroform. In chronic alcoholics ether may be given in the latter part of the anesthetic, but the degenerative changes occurring in the arteries and kidneys of such subjects must be seriously considered before its employment. On the other hand, if chloroform is used at first, great care should be exercised because of the depressant action of the drug on the circulation,—a circulation which has been weakened by not having its full quota of alcoholic stimulation for some hours previous to operation, and in many cases a much longer period of abstinence. In acute infections with pronounced constitutional disturbances ether has no place in the category of anesthetics, because it reduces phagocytosis by its action on the serum and leukocytes, as shown by Graham. Natural resistance is lowered, and the patient handicapped by the barriers of immunity being lessened.

The Administration of Ether.—The preliminary steps are the same as have been described under chloroform, and the anesthetic slip is filled out in the same routine manner. There are three ways by which ether may be administered: (1) The open method; (2) the semi or partially open method, and (3) the close method. "These names are used to designate the amount of air limitation the patient receives." I shall only describe the open and semiopen methods.

The Open Method—The Inhaler.—The simple Esmarch inhaler as has been described under "Chloroform" is employed. The same should be covered by six or eight thicknesses of 14 by 20-mesh gauze so as to afford rapid evaporation.

Ether Container.—This is similar to the one described under chloroform.

The Inhalation.—

(1) Hold the inhaler about one or two inches from the face.

(2) Drop the ether about twenty to thirty drops per minute, care being taken to diffuse the drops over a large surface of the gauze. By this means a more thorough admixture of the ether with air occurs.

(3) Gradually lower the inhaler and increase the frequency of the drops so that by the end of ten minutes the mask is practically touching the pa-

tient's face, while the frequency of the drop will probably be fifty or sixty per minute. Distribute the anesthetic over a large surface of the inhaler.

(4) After surgical anesthesia is obtained decrease the amount of ether to a point sufficient to maintain the anesthetic state; the amount will vary in different individuals.

The consideration of the patient's respiration and pulse, and the stage of excitement which may develop after the first four or five minutes of the administration, will be explained when describing the *partially open method.* However, I can do no better than mention here the fact that the so-called "stage of excitement" can in most cases be prevented if the patient has been properly prepared by pre-anesthetic alkaloidal narcotics, and *is not overwhelmed from the first* by the irritating vapor of the drug which I think is in most cases responsible for these untoward exhibitions. The keynote in the administration of ether is the *gradual increase* of the dose until the anesthetic state is obtained, then a *proportionate decrease* to maintain surgical anesthesia.

ILLUSTRATION LIX

An Allis Inhaler.—Showing the three parts of which it is composed

The Semi or Partially Open Method—The Inhaler.—The simplest form of apparatus is that designed by Dr. Allis of Philadelphia, and is the inhaler of choice in this country. This can be accounted for not only on the grounds of simplicity, but in the hands of the unskilled there is less danger accruing to the patient than when a more complicated design is employed; while the

expert anesthetist is capable of developing and maintaining as tranquil an anesthesia as with the more intricate inhalers. It consists of (1) a metallic oval jacket open at both ends; (2) a similarly shaped fenestrated cylinder which fits within the outer jacket, the depth of this cylinder being about one inch less than the outer jacket (the inner cylinder is equipped by means of gauze of the proper width and mesh—14 by 20—as shown in illustration); (3) an inflated soft-rubber ring attached to the edge of the outer jacket which rests on the face of the patient. This attachment prevents undue pressure, besides conforming more thoroughly to the irregularities of the face.

ILLUSTRATION LIXa
An assembled Allis Inhaler

This inhaler can be sterilized by boiling, which of itself merits consideration. (See illustration LIX. Illustration LIXa shows the assembled inhaler.)

The Inhalation.—Dr. A. P. Heineck in his work on General and Local Anesthesia makes this epigrammatic statement: "Air slightly impregnated with ether is the first rule, and ether impregnated with air the second." With this axiom clearly impressed on your minds, carry out the following steps:

(1) Place the inhaler over the nose and mouth of the patient.

(2) Request the patient to breathe naturally, thus demonstrating that free respirations can be maintained.

(3) Begin the administration of ether by slowly dropping the drug through the top of the inhaler on a large surface of the absorbing material with which the inner cylinder is equipped.

(4) Observe the respirations *as carefully at this stage as any other time of the administration,* as the irritating effects of ether on the nerves of the upper respiratory tract during this period may cause spasm of the glottis or temporary inhibition of respiration. The respiratory movements *at first* are considerably accelerated and deepened. As *the anesthetic state is developed* these become slower, yet continue deep and regular, but not stertorous; as the *lethal dose is approached* the respirations become more and more shallow until they are gradually extinguished. *The character of the respiratory movements and the force of the expirations are the signs which should be carefully watched.*

(5) Note the character and rate of the pulse by palpation of the temporal or facial arteries. If this latter vessel is utilized for this purpose as it passes under the angle of the lower jaw, the palpating hand can also hold upward and forward this member, and thus permit a free access of air. During surgical anesthesia the head has a tendency to fall forward because of the relaxation of the muscles and thus constrict the larynx. During *the early period* of the administration of ether anesthesia the pulse is quickened and its tension increased. As the *anesthetic state is developed* the condition of the circulation approaches the normal, excepting, possibly, that the arterial tension is still somewhat increased. As the *lethal dose is approached* the blood-pressure falls, and the pulse becomes smaller and irregular until eventually it is imperceptible.

(6) If the respiratory movements are free and deep, gradually increase the amount of ether until its full physiologic effects are obtained—care being taken to diffuse the ether widely over the absorbing surface of the inner cylinder.

(7) Watch the color of the face, ears, and lips; this will be another indication as to the condition of the respiratory and circulatory systems. The face during the administration of ether should be a bright pink, never cyanotic. Occasionally red patches are seen on the neck, chest, and upper abdomen,—the so-called "ether rash"; as far as we know these have no significance. The skin becomes moist with perspiration as the anesthesia progresses.

(8) Observe the pupil of the eye, which at first is somewhat dilated, but as surgical anesthesia is developed gradually assumes a contracted state. A sudden dilatation during this stage is an indication of lethal dosage.

(9) After surgical anesthesia has been obtained reduce the amount of anesthetic by decreasing the frequency of the drops, *not by withholding the drug for several minutes and then swamping the patient with a dram or two of ether.* Remember the respiratory movement is rhythmical, therefore administer the ether rhythmically. *The character of the respirations is about*

as good a guide as one can have in maintaining the required depth of the anesthesia. Surgical anesthesia is generally obtained in from eight to fifteen minutes.

Signs of Normal Surgical Anesthesia.—Among the most prominent may be mentioned:

(1) Loss of consciousness.

(2) Slow, regular, and deep breathing.

(3) Muscular relaxation.

(4) Contracted pupils.

(5) Lid reflex abolished.

Untoward Conditions.—With the advent of the skilled anesthetist and the modern pre-anesthetic preparation of the patient there has disappeared to a very large extent that condition which was formerly encountered in the early period of the administration of anesthetics, known as the "stage of excitement." It must be candidly admitted that the primary effect of ether on the brain is one of exhilaration,—the patient has fanciful ideas, possibly may be talkative or pugnacious. This effect of the drug *can be decreased to a considerable extent by the administration of morphin-atropin or other narcotic alkaloids* some time before the anesthetic is begun so as to produce a quiescent state of cerebral centers. Moreover the "stage of excitement" is frequently the result of improper administration of the drug—the patient being *literally deluged from the first* with ether, instead of having the dose *gradually increased* as tolerance is obtained. The same is true in those cases in which spasm of the glottis or inhibition of respiration occurs. These complications *in the majority of cases* will not occur if a proper dilution of the ether vapor is permitted during the early administration of the drug. If, however, "stage of excitement" is developed, under no consideration follow the plan advised by certain anesthetists to increase the dosage and summon aid to restrain the patient, because the increased amount of ether vapor will produce irritation of the respiratory tract and increase the complexity of the administration. The rule should be to withdraw the anesthetic, allow a free access of air to the patient, and then gradually increase the ether vapor. There are some subjects, and these are a very small minority, in whom it will be necessary to obtund the cerebral excitement by first administering chloroform and then resorting to ether. In the last 3,700 etherizations at the Protestant Hospital only five per cent. showed signs of the "stage of excitement," because the administration of this drug has developed under the supervision of Dr. E. C. Ludwig to a point approaching perfection.

The presence of a large amount of mucus in the throat is not uncommon during the administration of ether. The indications are to turn the patient's

head to the side and swab the throat and mouth with absorbent cotton attached to dressing forceps or a hemostat. This condition, which is very irritating both to the surgeon and anesthetist, does not frequently occur if atropin is used as a pre-anesthetic measure. Vomiting is simply a sign of too light an anesthetic. The vomited material may be inhaled into the bronchi and become a serious complication. The indications are met by immediately turning the patient's head to the side, removing any accumulations from the mouth and throat, and then increase the dose of the drug.

Accidents Occurring During Ether Anesthesia.—The most serious emergency which has to be met is respiratory failure, the treatment for which will be artificial respiration and Laborde's method of manipulating the tongue, in connection with oxygen. Both of these maneuvers have been described under "Chloroform."

Nitrous Oxid—*Physical and Chemical Properties.*—Nitrous oxid is a clear, colorless, practically tasteless, and odorless gas, somewhat heavier than air, and with a specific gravity of 1.527. It is neutral to litmus paper. Cold water absorbs three-fourths of its bulk of this gas. Nitrous oxid is liquified by the use of cold and pressure, in which state it is a colorless and mobile fluid. The pressure and temperature necessary to accomplish this being fifty atmospheres at 44.6°F. (one atmosphere is the pressure of the air at sea level—14.7 pounds). The gas is marketed in this liquid form in steel cylinders of various sizes (100 to 3,500 gallons under 750 lbs. pressure) and can be kept indefinitely, as decomposition does not take place unless it is exposed to an *extremely high temperature.* Nevertheless *it expands readily* as the *temperature is raised,* which should be remembered when storing the cylinders. When released from these steel containers it reforms into gas, at the same time producing intense cold and the formation of a plug of frost which obstructs the valve of the cylinder and interferes with the mixing apparatus. The greater the capacity of the steel containers and the larger the valve connected thereto the less liable is this to occur,—a point to be remembered in selecting the proper size containers, especially for hospital use. Nitrous oxid does not support life, yet in the presence of fire an increased vigor is obtained in the flame by the liberation of its oxygen. At the present moment some hospitals are equipped with facilities for manufacturing nitrous oxid, which reduces its cost to a minimum. After the gas is manufactured and washed it is passed into a large gasometer from which it is pumped into various sized cylinders; under such conditions the pressure is not carried to a point sufficient to liquify the gas.

Physiologic Effects Produced by the Inhalation of Nitrous Oxid—The Blood.—When inhaled this drug passes through the alveoli of the lungs, through the thin walls of the pulmonary capillaries which surround the air

cells, and thus diffuses itself in the circulation. It is unanimously agreed by all investigators that, although a part of the nitrous oxid is dissolved in the blood, *no chemic compounds are formed.* According to Buxton the gas "is connected in some loose way with the blood constituents, probably being associated more or less with the albumins and albuminoids of the liquor sanguinis and corpuscles." Pickering agrees with the same authority "that nitrous oxid is taken into a loose association with the hemoglobin of the blood." A reduction of hemoglobin is present after the inhalation of this gas, but such reduction *is only transient* and is seen in all asphyxial states *however produced.* Although there is this loose association or connection between this gas and the blood, nitrous oxid *displaces the oxygen in the constituents of this fluid,* but this displacement is *very evanescent*: immediately nitrous oxid is withheld and oxygen exhibited, the blood *gives up its latent nitrous oxid.* In other words, *the displacement is transient and mechanical, and no chemic changes occur.* Phagocytosis *is not reduced* as a result of the inhalation of nitrous oxid, nor is *disintegration of the red blood-corpuscles produced,* both of which have a practical bearing when considering its field of usefulness.

The Cerebro-spinal Nervous System.—The *primary effects* of nitrous oxid on the higher intellectual centers is one of exhilaration. This condition is *very rapidly* changed to a state of obtunded intellectuality and finally unconsciousness, with the development of the true anesthetic condition. At this time spasmodic contractions of the entire muscular structure of the body ensue, undoubtedly due *to the deoxygenation* of the blood, which is manifested by pronounced cyanosis. *If a correct percentage of oxygen* is now administered with the nitrous oxid the jactations of the members cease, the muscular rigidity is greatly reduced, and the cyanosis disappears.

Although some authorities claim that anesthesia is produced by a specific action of this drug on the cerebro-spinal nervous system, so far they have failed to show what the specific action is. I am inclined to think from clinical observation that the physiologic action of nitrous oxid on the brain-cells is one of *inhibition;* that is to say, the normal amount of oxygen which is necessary for the functionating capacity of the brain-cells is displaced by the presence of nitrous oxid, and these cells are *inhibited* in their function in proportion to the amount of this oxygen displacement. In other words, anesthesia produced by this gas is simply mechanical,—mechanical anoxemia. This phase of the question cannot be further discussed in a lecture of this character. (See section "Local Anesthetics Employed Contemporaneously with General Anesthetics.")

The Heart and Circulatory System.—Nitrous oxid is primarily a heart stimulant. Its action on the vasomotor center is stimulating to the extent

that blood-pressure is increased and maintained so that animals under the influence of this gas (in combination with the proper proportion of oxygen) will withstand four times the amount of shock-producing trauma as compared with ether. When a lethal dose is administered the heart is slowed and death occurs by a combination of asphyxia and cardio inhibition. Contrary to the general advice, Crile maintains "the heart is the key to the situation, the warning being too much slowing." Other authorities say that the heart continues to beat long after the respirations have ceased. This apparent incongruity of opinions is easily explained on the ground that Crile in his statements refers to nitrous oxid-oxygen administration, while other authorities base their opinions on pure nitrous oxid. Doctor Crile is right in his statement, that the condition of the heart is the index of the patient's true state, when the combination of gases is used.*

The Respiratory System.—Nitrous oxid is in no way irritating to the pulmonary apparatus, nor is there any postanesthetic complications following its use. The respirations under the influence of this drug are deep and more rapid than normal at first; as the *lethal dose* of the gas is approached the respirations become shallow and slower, until finally inhibition of respiration results. If the views which are at present entertained, that postoperative lung complications are autogenous infections,—that is to say, the specific organisms are latent within the patient,—and that the operative trauma, surgical shock, and other deleterious influences that reduce body-resistance are the factors which permit these latent germs to gain a foothold and produce postoperative pulmonary complications, it can be easily understood from the following deductions why nitrous oxid-oxygen anesthesia does not cause pulmonary sequelae.

(1) Phagocytosis is not reduced.

(2) The patient is capable of withstanding four times as much surgical shock as compared with ether.

(3) Being non-irritating to the mucous membrane of the respiratory tract, the local resistance is maintained in the pulmonary apparatus and any latent microörganisms are thus prevented from gaining a foothold.

(4) Nitrous oxid *is not a solvent of fats* and therefore aspiration pneumonia does not occur as with ether or chloroform, both of which latter dissolve the oily infectious debris that collects around the teeth and becomes one of the sources of postoperative pulmonary complications.

The Digestive and Urinary Systems.—Nitrous oxid has apparently no action on either of these systems, so that nausea or vomiting is seldom a post-

* See article, "Nitrous Oxid vs. Ether," by George W. Crile, M. D., Southern Medical Journal, January, 1910.

anesthetic complication; nor does it produce changes in the structure of the liver as is seen in chloroform. Its effects on the structure of the kidneys are negative, while the urinary excretion is in no way interfered with.

Indications and Contraindications for the Use of Nitrous Oxid-oxygen.—To facilitate the further consideration of this subject nitrous oxid-*oxygen* alone will be considered—a point which must be clearly borne in mind. If the extravagant statements made by some of the enthusiastic advocates of nitrous oxid-oxygen were to be taken seriously the conclusion would be reached that there were no contraindications for the use of the combined gases. On the other hand, if the views of the pessimistic anesthetist who has never given the subject of nitrous oxid-oxygen due consideration nor spent the required length of time to learn the proper technic for its administration, were conclusive, one would be forced to conclude that nitrous oxid-oxygen should be relegated to dentistry and minor surgery. The facts are, while nitrous oxid-oxygen *has some deficiencies* as an anesthetic, yet it possesses a larger scope of usefulness than any of its competitors, because of the following reasons.

(1) It does not reduce phagocytosis, hence does not impair immunity, which claim ether does not possess.

(2) Disintegration of the red blood-corpuscles does not occur after its administration.

(3) The patient is capable of withstanding four times more operative trauma under nitrous oxid-oxygen than under ether before shock is produced.

(4) It increases the blood-pressure, and yet this increase is practically under the control of the anesthetist.

(5) Postoperative complications are exceedingly rare as compared with ether, besides which there is seldom any postanesthetic nausea and vomiting which so frequently is encountered with other drugs of this class.

(6) It does not reduce body-temperature, which is the reverse of ether.

(7) No deleterious effects are produced in the patient however long the state of anesthesia is continued. The same cannot be said of any other anesthetic.

(8) The cerebral-cells being in an anoxemic condition are not as receptive to external stimuli as under ether.

(9) The excretory organs of the body, the kidneys, are in no wise affected by its administration, hence, the economy can rid itself far easier of toxic elements.

Nitrous oxid-oxygen therefore is indicated in operations associated with the general infections such as septicemia, or in any of the acute infections, as appendicitis. In emergency operations performed for pathologic conditions, such as a leaking gall-bladder, a perforated stomach or intestine, and ectopic pregnancy, nitrous oxid-oxygen is by far the safest anesthetic. In emergencies due to violent causes such as the result of industrial accidents, gunshot wounds, etc., the combination of these gases is far preferable to ether. In operations that will consume a long period of time, in which shock or hemorrhage is anticipated, nitrous oxid-oxygen will conserve the patient's resistance far better than ether. In patients handicapped by chronic disease, with the usual degenerative blood-changes, nitrous oxid-oxygen should be used. In valvular disease of the heart if compensation is restored nitrous oxid-oxygen may be employed, but if degenerative changes have occurred in the heart muscle, or dilatation with its accompanying edema is present, nitrous oxid-oxygen is not indicated, nor do I consider any other anesthetic proper, *unless in extreme necessity.* In operations associated with sclerotic arteries and high blood-pressure, but yet with no loss of cardiac compensation, I consider nitrous oxid-oxygen *at least as safe as ether, if administered by a skilled anesthetist,* because the increased blood-pressure produced by ether cannot be regulated, while with nitrous oxid-oxygen the greater the percentage of oxygen combined with the anesthetic, the less will be the increased vascular tension; besides which, associated with sclerotic arteries is commonly found chronic interstitial nephritis,—Bright's disease,—a condition which certainly is not improved by the administration of ether. Likewise in operations on any portion of the urinary tract nitrous oxid-oxygen is well indicated. In operations on the brain nitrous oxid-oxygen has always been considered dangerous, because of the increased intracranial pressure it produces. *The amount of intracranial pressure can be regulated at the will of the anesthetist by the amount of oxygen combined with the nitrous oxid.* The larger the per cent. of oxygen the less will be the intracranial pressure and vice versa. I have in my own practice caused the brain to protrude at least one quarter of an inch through the opening in the skull, by having the anesthetist administer practically pure nitrous oxid, and then by combining 15 per cent. of oxygen with the anesthetic, immediately produced a contraction of the brain to the extent that the organ appeared too small for the cranial vault. The hues of color in the superficial blood-vessels of the cortex varied from the darkest to the brightest red according to the percentage of oxygen. The caliber of the vessels was increased to an enormous extent when practically pure nitrous oxid was given, but contracted instantly when a large amount of oxygen was combined with the

anesthetic. *Intracranial pressure can be regulated by the expert anesthetist.* In operations on the thorax nitrous oxid-oxygen can be safely employed, and especially is it indicated where the surgeon desires the patient to be in the sitting posture. In operations associated with acute or chronic bronchitis nitrous oxid-oxygen is certainly preferable to ether, because it produces no irritating effects on the pulmonary passages. I do not believe it is contraindicated, as some authors state, in operations associated with pulmonary tuberculosis because of the fear of producing hemorrhages. The administration of oxygen in the proper proportions will obviate any danger from this source by preventing an excessive increase in blood-pressure. Furthermore nitrous oxid-oxygen has been employed in the presence of pneumonia without producing any harmful effects. In operations on the thyroid gland nitrous oxid-oxygen is used with marked success. Not only are its beneficial effects manifested during the operation, but the postoperative neurasthenic condition is by no means as marked as when ether is used. Nitrous oxid-oxygen anesthesia is generally inadequate to produce a sufficient amount of relaxation of the abdominal wall in celiotomies occurring in highly developed muscular patients to permit complete freedom of operative measures; under these conditions a few drops of ether are mixed with the nitrous oxid-oxygen gases to "soften" the rigidity of the muscular structure. It will be a surprise to the uninitiated to witness the immediate relaxation which occurs, also the small amount of ether required (generally not more than ten or fifteen drops), and the duration of the relaxation.

I prefer ether or chloroform to nitrous oxid-oxygen when operating on young children, because the pre-anesthetic alkaloidal narcotics which should be employed with the combined gases are exceedingly dangerous to this class of patients *in any dose,* and if dispensed with the excessive struggling of the child causes too rapid an anoxemic condition to develop,—at least this has been my experience.

I prefer chloroform when operating on the mouth, throat, and nose, because air cannot be entirely excluded and prevents a tranquil anesthesia if nitrous oxid-oxygen is employed. A surgeon has no right to prejudge the period necessary for a tonsilectomy because an unlooked for hemorrhage may occur, which complication is better combated in this class of cases when the patient is entirely in repose. My preference is for other anesthetic agents when operating on the *rectum.*

When there is a *marked reduction* in the hemoglobin index, the employment of *any anesthetic is dangerous.* While nitrous oxid does not produce anemia, nor any permanent changes in the blood, I would consider this gas

as inappropriate as any other anesthetic when the hemoglobin index is very low, because the great deficiency of hemoglobin in such subjects would practically permit a complete displacement of all oxygen in the presence of nitrous oxid-oxygen, and a true asphyxial state would ensue. On the other hand, if a sufficient amount of oxygen were employed to offset this total displacement, I doubt if sufficient anesthetic effects would be obtained. This deduction is made purely on theoretical grounds, and is simply offered as a suggestion. I have, however, by transfusion previous to operative measures raised the hemoglobin index from 18 to 35 per cent. and red blood-cells from 2,100,000 to 3,700,000 in a patient exsanguinated from uterine fibroids, and then administered nitrous oxid-oxygen with the most perfect results. I am satisfied that no anesthetic could have been given unless transfusion had first been utilized, and I am also convinced that no anesthetic would have maintained the stability in the blood as did this combination of gases. The results of the examination of the blood after operative interference were practically the same as before such measures were instituted. *One of the greatest contraindications for the use of nitrous oxid-oxygen anesthesia is an incompetent anesthetist.* Given such an individual, ether is the safer anesthetic.

Administration of Nitrous Oxid-oxygen.—There is no anesthetic which requires more special training in its administration than nitrous oxid-oxygen. The anesthetist must not only be dexterous, but keen in observing and analyzing the different symptoms and stages of anesthesia through which the patient passes. So rapid is its action that the subject can pass from complete surgical anesthesia into the full possession of all the faculties in a period of time that may be counted in seconds, so that you can appreciate what skill is required to maintain a tranquil anesthesia. In fact I am fully convinced that the unfavorable opinions concerning the scope of usefulness of these combined gases emanate from anesthetists unqualified in the administration of nitrous oxid-oxygen. Because a man is a skilled ether or chloroform anesthetist does not signify that he is qualified to administer nitrous oxid-oxygen. Few anesthetists are at the present time qualified to administer the combined gases, and because of this fact they become pessimistic on the subject and attempt to influence the surgeon against the adoption of this form of anesthetic. This I have noted in several hospitals which I have visited. The time will come when the anesthetist will be required to be just as skillful and efficient in the administration of nitrous oxid-oxygen as in the other anesthetics.

The following nitrous oxid-oxygen chart is an easily kept and practical form and should be compiled during the administration of the anesthetic:

Nitrous Oxid-oxygen Anesthetic Slip.—

Name of patient....................................
Room number ....
Pulse ....Respiration.......Blood-pressure........
Anesthetic started ....
Initial per cent. of nitrous oxid.......................
Initial per cent. of oxygen............................
Anesthetic completed................................
Operation started ....

TIME	PULSE	RESP.	BLD. PRES.	PER CENT. NIT. OXID.	PER CENT. OXYGEN*

Anesthetic ended ....
Operation ended ....
Amount of nitrous oxid used (estimated)..............
Amount of oxygen used (estimated)..................
Hypodermatic medication used........................
Packing or drainage used...........Where...........
Character of operation ....
....
....
Anesthetist ....
Date ....

*Records of pulse, respiration, and per cent. of the combined gases should be made every five minutes. If the operation be a very hazardous one the blood-pressure should also be noted.

Preliminary Steps.—

The place of administration—operating-room.*

Choice of location—operating-table.

Posture—flat recumbent, unless a special position is desired.

(1) Observe if the patient is sufficiently covered.

(2) Ascertain if false teeth have been removed, or if any foreign body is in the mouth.

(3) Instruct the patient to breathe naturally.

(4) After a few seconds' inhalation, have the hands of the patient secured in an appropriate manner by an attendant.

Several of the preliminary steps which are utilized when ether and chloroform are administered are omitted, for instance, the cocainizing of the nares and pharynx is not necessary because nitrous oxid is not an irritant, and for the same reason the face demulcent and the artificial protection for the eyes are dispensed with.

The Apparatus.—A special apparatus with the following requirements is necessary for the administration of nitrous oxid-oxygen. (See illustration LX.)

(1) *A continuous and even flow of the gas and oxygen under a positive and known pressure,* this pressure being regulated at the will of the anesthetist.

There are two methods employed to maintain a constant and even pressure.

First, attach a large high-pressure cylinder (preferably 3,500 gallon capacity) by means of suitable hose to the nitrous oxid apparatus. Reduce the output of the high-pressure cylinder to about 20 pounds by means of the pressure-regulating valve with which it is equipped.

The valve on the apparatus which permits the flow of the gas into the rubber bag further reduces the pressure, and finally the valve attached to the inhaler delivers it to the patient at one- to three-ounce pressure, which can be adjusted at the will of the anesthetist. The use of cylinders of 100-gallon capacity should not be used in hospitals; the small valves with which these are equipped and the pressure exercised by the gas when released produces the frost plug which has already been spoken of, and prevents a continuous and even flow of the gas.

* The time consumed in transferring the patient from the anesthetizing-room to the operating-room as in other anesthetics would be sufficient for the patient to recover from the anesthetic, and would necessitate beginning the administration over again.

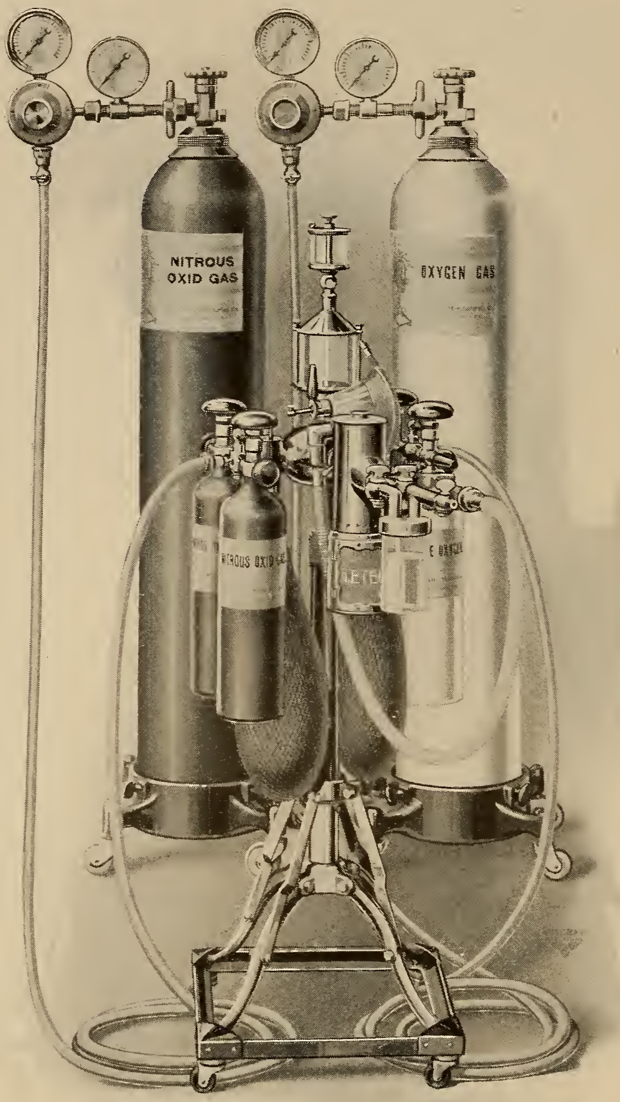

ILLUSTRATION LX

A Teter Apparatus for the Administration of Nitrous Oxid-oxygen

Second, a plant installed in the hospital for the manufacture of nitrous oxid. The gas is pumped from the gasometer and compressed (not liquified) in large storage tanks holding from 800 to 3,500 gallons. The required pressure is maintained *in the pipes leading to the operating-room by regulating valves.* When this plan is adopted the cost to the institution is reduced to the minimum, and the administration of the anesthetic is simplified, because of the constant and even pressure that is obtained.

(2) *A mechanical device* for accurately increasing or diminishing the per cent. of either gas.

(3) *A mixing chamber.*

(4) *Some means of warming the combined gases* (90° to 94°F. when inhaled). By this means several advantages are gained, viz.—

(a) A more thorough and tranquil anesthesia is produced.

(b) The pulmonary passages are protected from the refrigerant action of the cold nitrous oxid.

(c) Expansion of gas occurs before inhalation, and immediate absorption takes place after being inhaled.

(5) *An ether reservoir* which is so constructed as to permit a definite admixture of this drug with the combined gases when necessary, or if ether is to be given in sequence to nitrous oxid-oxygen the construction of the apparatus should permit of the elimination (or shutting off) of the nitrous oxid-oxygen entirely, and the administration of a definite amount of warm ether with atmospheric air alone, or in combination with oxygen.

(6) *An inhaler* consisting of a celluloid cone to which is attached a pneumatic rubber ring which permits of an accurate and easy adjustment to the contour of the face. The celluloid being transparent enables the anesthetist to observe the color of the patient's face and lips, and if retching ensues to note if any vomitus has been expelled without raising the cone. This is important because if air is admitted a readjustment of the percentages of gases will be necessary. The inhaler is also equipped with *expiratory and pressure valves. It is this latter valve which regulates the final pressure before inhalation.* The inhaler is attached to the apparatus by means of a high-pressure rubber hose. (See illustration LXI.)

A nasal inhaler constructed similarly to the above is employed in operations on the mouth and throat.

(7) *A rebreathing attachment* for those anesthetists who desire to conserve the supply of gas. I am fully convinced, however, that rebreathing is not scientific and is based on false premises. If economy is the only reason

for the employment of rebreathing, which apparently is the argument put forth, the profession should think well before adopting a plan of commercialism which may be deleterious to the patient.

In my opinion the Teter apparatus embodies all these principles; it is the apparatus used in my clinic.* *But after all it is not the kind of apparatus alone that is necessary, it is the dexterity with which the apparatus is manipulated, and this dexterity depends on intelligence combined with careful study of the physiologic action of nitrous oxid-oxygen.*

ILLUSTRATION LXI

Nitrous Oxid-oxygen Face Inhaler

The Inhalation.—

(1) Inspect the nitrous oxid-oxygen apparatus and ascertain if it is in working order and whether an ample supply of both gases is on hand. Regulate the pressure valves. *Note the odor of the gas before administration.* This appears to be compulsory inasmuch as deaths have been reported which undoubtedly were due to the fact that nitric-oxid was being administered and not nitrous-oxid. Nitric-oxid has an odor peculiar to itself.

(2) Place the inhaler over the mouth and nose of the patient, carefully noting that no air space remains between the pneumatic ring and the face, as ingress of air will defeat the purpose to be attained.

(3) Open the nitrous oxid valve sufficiently to partially inflate the rubber bag connected with this gas and adjust it to a point that will keep the bag partially full.

(4) Open the valve connected with the oxygen cylinder and inflate the rubber bag connected with this gas and keep it inflated throughout the operation.

* I am indebted to Dr. C. K. Teter, Cleveland, Ohio, for many of the suggestions offered.

(5) Permit the patient for the first few seconds to inhale either pure nitrous oxid until a slight cyanosis appears, or nitrous oxid combined with a very small amount of oxygen (3 per cent.).

(6) Observe the respirations by watching the respiratory action of the thorax and maintain a *rhythmical action of the expirations.* By this is inferred, each *expiration should be of the same quality.*

(7) Note the rate and character of the pulse, which at first will be faster than normal, yet possessing increased tension, but gradually approaching the normal. To facilitate the counting of the pulse utilize the facial artery as it passes under the angle of the jaw, the palpating hand supporting the head as has been described under "Ether" and "Chloroform," bearing in mind that *the character of the pulse is the indication as to the true condition of the patient,—too much slowing* of the heart's action means excessive nitrous oxid dosage.

(8) Carefully note the color of the face. While cyanosis is present during *the first few seconds in the administration of pure nitrous oxid, after the proper admixture of oxygen with this gas this should disappear and remain absent.*

(9) After surgical anesthesia has been developed, gradually reduce the amount of nitrous oxid and proportionately increase the amount of oxygen, so that possibly 90 per cent. of nitrous oxid is being administered and 10 per cent. of oxygen. There can be no set rule governing the amount of these gases, but *a constant stream of oxygen must always be present.* There is no step in anesthesia that *requires more dexterity and a greater nicety of adjustment* than the variations in the percentages of these two gases for different individuals. After the adjustment has been obtained, however, there is probably no anesthetic with which the anesthetist can work with greater facility.

(10) Do not permit the final preparation of the field of operation to be begun until the patient is completely anesthetized. This is a point which cannot be too strongly insisted on,—disturbing the patient before this stage is reached frequently prevents the development of a tranquil anesthesia.

(11) If the combined gases have been given in correct proportions and the patient not suddenly asphyxiated, anesthesia will develop in from two to three minutes.

Signs of Normal Surgical Anesthesia.—The respirations are regular and deep, not shallow and slow, and *never stertorous.* The arm falls helplessly to the side if raised, but muscular relaxation possibly is not as complete as under ether and chloroform. Conjunctival reflex is absent.

Untoward Conditions.—Should asphyxial symptoms develop during the first few seconds of the administration of pure nitrous oxid, and the admixture of a small amount of oxygen restores the patient, only to have similar symptoms return when nitrous oxid is again administered, it is far better to *reduce the amount of nitrous oxid to a minimum* and add a few drops of ether in combination with a small amount of oxygen, then gradually increase the per cent. of nitrous oxid-oxygen, at the same time proportionately decrease the ether until entirely dispensed with. In this way the respiratory center is not suddenly suspended by lack of oxygen, but gradually led up to the desired point when gas-oxygen may be continued. It is under these conditions that the unskilled anesthetist begins a battle which sooner or later exhausts the patient, and gives rise to unfavorable comment.

If during the administration of the anesthetic the respirations become shallow and slow, and the anesthetist finds that by increasing the oxygen the patient has a tendency to come from under the influence of nitrous oxid, the admixture of 10 or 15 drops of ether with the combined gases will at once accelerate and deepen the respiratory movements because of its known stimulating action on this system.

It sometimes happens, as in other anesthetics, that sudden cessation of respiration is due to the tongue falling backward and obstructing the larynx; this should be borne in mind and provisions made for relieving the obstruction by pulling the tongue forward.

The muscular structures are not as completely relaxed under nitrous oxid-oxygen as under ether or chloroform, but if the patient has been properly prepared by the administration of the pre-anesthetic alkaloidal narcotics, such as morphin and hyoscin, this deficiency is practically overcome. In celiotomies performed on highly developed muscular subjects a few drops of ether will "soften" abdominal muscles and permit as wide a latitude of operative manipulations as under any other anesthetic; it will be a surprise to the uninitiated to note the small amount of ether necessary for this purpose (not over 15 or 20 drops), and the duration of the relaxation.*

Accidents Occurring During Administration of Nitrous Oxid-oxygen.—If during the administration of gas-oxygen the patient develops *profound cyanosis, or the heart's action becomes very slow,* nitrous oxid is immediately suspended and pure oxygen administered, when the patient will at once return to a normal condition. In fact oxygen is the key, indirectly or directly, to all accidents occurring during the administration of nitrous oxid. *If the respirations cease entirely,* artificial respiration or Laborde's method

* In my last 200 operations under nitrous oxid-oxygen as administered by Dr. R. A. Rice of Grant Hospital, ether has been entirely dispensed with and the most perfect results have been obtained.

of rhythmical movements of the tongue in addition to the administration of oxygen, should be instituted. (See section "Artificial Respiration" of this lecture.) *If the heart is suddenly checked in overdilation, cardiac massage* as has been described when speaking of "Chloroform," should be employed. While I have never witnessed such an accident, I would not consider it advisable to place the patient in the Trendelenberg position, inasmuch as the blood gravitating to the already dilated heart would produce further distention of that organ.

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C. K. Teter, D. D. S., Cleveland, O.

PHYSICIANS, SCIENTISTS, AND OTHERS QUOTED

Doctors

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- Boyd, Francis B.
- Buxton, D. W.
- Coons, J. J.
- Crile, Geo. W.
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- Darnell, Carl R.
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- Eisendrath, Daniel N.
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- Hartley, Frank
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- Kelly, Howard A.
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- Lister, Sir Joseph

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